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THE LOWER TERTIARY FLORAS OF SOUTHERN ENGLAND

III

FLORA OF THE BOURNEMOUTH BEDS; THE BOSCOMBE, AND THE HIGHCLIFF SANDS

BRITISH MUSEUM (NATURAL HISTORY)

THE LOWER TERTIARY FLORAS OF SOUTHERN ENGLAND

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FLORA OF THE BOURNEMOUTH BEDS; THE BOSCOMBE, AND THE HIGHCLIFF SANDS

BY

MARJORIE ELIZABETH JANE CHANDLER

With twenty-five plates
and thirty-three figures in the text

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PREFACE

THIS volume completes the series of three monographs by Miss M. E. J. Chandler on the *Lower Tertiary Floras of Southern England* and deals, in particular, with the Eocene Freshwater and Marine floras of Bournemouth.

Most of the material described in the present work was collected by the author herself and again we are indebted to Miss Chandler for presenting to the National Collections the result of many years' patient work in field and laboratory.

Miss Chandler's three major works, together with a number of separate papers dealing with smaller but equally important floras published in the *Bulletin* of the British Museum, bring to a close more than thirty years' intensive study of angiosperm fruits and seeds, ferns and conifers, from the Thanet Beds of Kent to the Oligocene of the Isle of Wight and the Bovey Tracey Lake Basin.

As in the two previous volumes the author's Introduction is of much interest and importance and it is hoped that a general survey of all the previously described floras by Miss Chandler will be forthcoming in the near future.

The photographs for the plates are by the author herself as in all her other publications, and Mrs. Jane Croucher has made the excellent drawings reproduced in the text, based on Miss Chandler's sketches.

The splendid help given by Dr. K. I. M. Chesters and Mr. F. M. Wonnacott in bringing this venture to a successful conclusion is liberally acknowledged by Miss Chandler in her Preface; but I would wish to add my own thanks to hers for their selfless and cheerful industry.

ERROL WHITE,
Keeper of Palaeontology

12 May 1961

AUTHOR'S PREFACE

THE present volume is the third in a series of large monographs on the *Lower Tertiary Floras of Southern England* at successive horizons. In addition there have been Bulletins of the British Museum (Natural History) dealing with some of the smaller floras which help to fill gaps in the sequence. It should now be possible, therefore, to present a fairly comprehensive picture of the Eocene floras of the area under consideration so far as it has been revealed by the study of fruits and seeds. It is hoped before long to prepare a short account of the main conclusions arising from the investigations. Reviewing the course of this work up to date it was really initiated nearly forty years ago with a paper on *Stratiotes* (Chandler, 1923) which included the examination of material from Lower Headon and Oligocene Beds. It was then continued more obviously in a preliminary study of the Lower Headon flora of Hordle, Hampshire (Chandler, 1925, 1926) and carried further, in collaboration with Eleanor M. Reid, by research upon the Oligocene Bembridge flora (Reid & Chandler, 1926) and the famous fruit and seed flora of the London Clay (Reid & Chandler, 1933). A long gap in publication then followed due to various circumstances outside the writer's control, but meantime research had continued although in somewhat obscure surroundings. However the peace of the milieu and the comparative freedom from interruption which it provided gave time not only for the investigation of the fossil material (always a long and often a tedious matter) but for prolonged collecting from productive sites which were soon to be closed or to become more or less inaccessible.

Now, when this series of studies is, temporarily at least, nearing completion, it seems appropriate to look back and acknowledge something of the debt to the past which has made these Monographs and Bulletins possible at all. Some acknowledgement of this debt has already been made in the Author's Preface to Volume I (Chandler, 1961: vii). Although it is not practicable to mention individually all the personal contacts which have influenced the work it cannot be out of place to put on record the profound influence of certain people. I therefore mention Eleanor M. Terrell, Science Mistress in a small school where no special provision for advanced science teaching could be made. She, during my school career, gave up much free time to provide the necessary basic instruction in different branches of science. At the University the memory of one chance encounter in the basement of the Sedgwick Museum, Cambridge with Thomas McKenny Hughes at the very end of his long Professorship and of a conversation then held with him has been a continuous inspiration. There came next a long succession of those whose tuition and encouragement have meant so much: Gertrude L. Elles, John E. Marr, A. C. Seward, E. A. Newell Arber (all at Cambridge), Herbert H. Thomas of the Geological Survey,

Dukinfield H. Scott always a kind friend and supporter, and then, in direct connexion with the British Museum, Sir Arthur and Lady Smith Woodward, Dr. F. A. Bather, Dr. W. D. Lang and W. N. Edwards.

Reserved for separate and especial notice are Eleanor M. Reid, friend and collaborator during many years and indirectly through her although never personally known Clement Reid; Dr. Kathleen I. M. Chesters and F. M. Wonnacott who between them have criticized, typed MS, edited, and read proofs, not to mention alternately frowning upon and encouraging successive efforts. This special list is not complete without mention of the present Keeper of Palaeontology, Dr. E. I. White, whose sympathetic attitude has made possible the publication of most of these volumes at a time when I had almost ceased to hope that they would ever see the light of day.

So is illustrated the fact that the present grows out of the past and all work owes its existence to those who have gone before. Again all work is merely a stepping stone to that which will come after, by which in great measure it may be superseded as techniques improve and knowledge advances. The study of fossil leaves at first held chief sway, they were so obvious they could not be overlooked. Then came that of fruits and seeds which in the early years of the present century no one, especially the botanists, could believe were capable of reliable determination. To demonstrate that they were Clement Reid and his wife carried out years of research on Pleistocene and Pliocene plant remains. This fortunate chance that they began with the more recent deposits from which fruits and seeds were capable of being matched exactly with living material eventually brought its reward in acceptance of these organs as evidence.

Today pollen has captured the imagination and enthusiasm of many workers in the Tertiary palaeobotanical field and there is, too, a growing tendency to pay more regard to wood. No one line of approach is sufficient in itself, and even when all have made their contributions the picture can never be complete, for the record, whatever the organs used and even when all have been taken into account, is inevitably imperfect while new interpretation of old facts must capture the field if any real headway is to be made.

MARJORIE E. J. CHANDLER

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INTRODUCTION

In volume II of the *Lower Tertiary Floras of Southern England* plants from the Pipe-clay Series of Dorset were described. The record is now continued into succeeding beds the oldest of which lie in Dorset, those above in Hampshire. These oldest beds, named by Gardner the Bournemouth Freshwater Series or Middle Bagshot Beds, are regarded as extending from Sandbanks on Poole Harbour eastwards to the Bournemouth East Cliff lift where they partly pass into and are partly succeeded by Gardner's Bournemouth Marine Beds. These in turn are overlain by the Boscombe Sands and the associated lignitic layers below and above. After the wide river gap at Christchurch Harbour the Highcliff Sands of Cliff End near Mudeford appear in the section.

A. The Freshwater Beds between Poole Harbour and the Bournemouth East Cliff Lift

1. GEOLOGICAL POSITION OF THE BOURNEMOUTH FRESHWATER BEDS

The Bournemouth Freshwater Beds are purely continental and are essentially similar in character and flora to the underlying Dorset Pipe-clay Series (Lower Bagshot Beds). They differ from these older beds in the sparse development of pipe-clay which is confined to small basins only, the infillings of mere puddles, whereas coarse grits, fine clays, silts and marls predominate. The relationship of such non-marine deposits to the European stages is inevitably somewhat arbitrary as already stated (Chandler, 1961: 8) where two alternative correlations are shown in a table. That favoured by Arkell (1947) included in the Cuisian the whole of the freshwater beds above the London Clay to the top of the Bournemouth Freshwater Series. The other suggested by Wrigley & Davis (1937, pl. 18) while placing Gardner's Lower Bagshot Beds in the Cuisian, referred the Bournemouth Freshwater Beds to the Lutetian but without any sharp delimitation of the boundary between the two stages. At an earlier date Gardner (1882*a*) had separated the Bournemouth Freshwater Beds from his Lower Bagshot (designated in 1962 the Dorset Pipe-clay Series following the Geological Survey) partly on account of the change in sedimentation mentioned above and partly because of a supposed difference which he thought he could detect in the floras. This difference, if it exists at all, may be due to variations of habitat represented at the two horizons or to differential sorting by specific gravity arising from the change in sedimentation rather than to any fundamental botanical difference. In this work Wrigley & Davis have been followed to the extent of treating the Bournemouth Freshwater flora quite separately from that of the Dorset Pipe-clays.

2. CHARACTER AND MODE OF FORMATION OF THE BOURNEMOUTH FRESHWATER SERIES

The Dorset Pipe-clay Series, found to the west of Poole, were thought to have been deposited by a river or rivers subject to severe floods. The probable conditions are indicated by Chandler (1962: 2, 3). The Bournemouth Freshwater or Middle Bagshot Beds, which have always been recognized as a continuation of the same continental sequence, were laid down nearer to the coast. Gardner believed that the more westerly beds of this Series displayed an upland flora with luxuriant forests superseded nearer Bournemouth in the neighbourhood of the existing pier by bushes with tracts of marshland, the two regions being connected by a tropical valley rich in vegetation (Gardner & Ettingshausen, 1879: 16–18). The rapid currents which were responsible for the deposition of the Bournemouth Freshwater Beds perhaps washed the finer sediments out to sea hence the relative scarcity of pipe-clay. There is evidence however of finely laminated silt of varying and sometimes considerable thickness especially at the base of the cliffs, for example near Sandbanks and at Simpson's Folly and in places below the coarser beds which form the main thickness of the cliffs. Such silts also occur between Alum Chine and Branksome Dene. They were seen for some distance in October 1955 when the promenade was broken by a storm. In places these basal beds have been eroded or distorted. Sometimes chunks of fine clay form a 'breccia' in overlying coarser sands. It seems probable that throughout the deposition of the coarse beds at least, the land was sinking, sedimentation keeping pace more or less with subsidence. The position of the river mouth must have varied with seasons and conditions, tides and storms producing the irregular bedding and confused strata. The change in the beds from place to place may be very rapid and the section itself alters from one season to another. In consequence detailed descriptions are only applicable in a limited degree or for a comparatively short time. The section revealed by the storm already mentioned afforded a good illustration of the variability of the Middle Bagshot Beds. Thinly bedded horizontal silts with close-set layers of fine carbonaceous matter at the cliff base suggest deposition under very tranquil conditions. The upper surface of these fine silty beds was an erosion plane overlain by a mud-breccia with abundant remains of rolled *Teredo*-bored wood. East and west the fine beds thickened considerably in places forming high 'cliffs' in the overlying coarse current-bedded orange and yellow sand. Not far west near Branksome Dene the thick deposits of a flood channel were exposed full of fine, battered carbonaceous matter giving them a purple tinge.

3. BOTANICAL IMPORTANCE OF THE FRESHWATER SERIES

These Bournemouth Freshwater Beds are of great palaeobotanical importance in that they yield an abundance of both fruiting organs and leaves. The beds thus offer an unrivalled opportunity of comparing and contrasting the evidence provided by these different organs. The two types of plant remains tend to occur separately in well defined lenticles or layers of limited extent although fruits are sparsely scattered through all the plant-bearing strata. It is most unfortunate that up to the present only the fruiting organs have been investigated to any appreciable extent. Many hundreds of leaves in the Gardner Collection preserved in the British Museum (Natural History) still await the attention of a specialist able to deal with that extremely difficult branch of palaeobotany. Leaves rather than fruits and seeds were assidu-

ously collected by the older workers probably because (apart from *Nipa*) they were larger and more conspicuous and it is their remains which made the Bournemouth cliffs geologically famous. When Gardner made his collection the cliff face was accessible without restrictions or obstructions of any kind. An old photograph in the Gardner portfolio shows labourers excavating in pits in one of the leaf beds (Coastguard Beds?), a method of work no longer possible. It explains why the leaf impressions collected were so perfect and numerous. Today the most prolific of the old leaf beds are no longer visible. The attempt to protect the cliffs from the sea and from surface degradation coupled with the development of Bournemouth as a popular resort has led to much planting and to the construction of bathing accommodation, promenades and sea walls which conceal the strata. In addition collecting is strictly forbidden so that fresh material can only be derived from fallen blocks. These restrictions and difficulties also frustrate the collector of fruits and seeds. Nevertheless a few good discoveries were made during the exceptional conditions which prevailed in 1944 when access to the shore again became possible after the war ended in Europe. The neglect of the war years then made available for a very short time a few fresh surfaces. It is probable that seed beds yield a greater variety in a small sample than leaf beds, hence such limited exposures may provide important evidence. No doubt eventually more varied information will be obtained by the extraction of pollen from the very small samples which appear to be sufficient for this kind of research.

4. EARLIER RECORDS OF PLANTS

The Bournemouth area like that of Alum Bay has for many years been regarded as classical palaeobotanically. In both cases, however, there was little real knowledge of the flora. That of Bournemouth was believed to be very extensive as witnessed by the size of the Gardner Collection in the British Museum (Natural History) containing over 6,000 specimens. It was also known to yield abundant palms and other plants of tropical type. Yet a very small list of valid species remains after removal of *nomina nuda* and doubtful determinations.

Gardner & Ettingshausen, or the former alone, described eighteen species of fern (1879–82), nine of which were well characterized and are included in the plant list on p. 19. At that time fertile pinnules were only known in the case of *Gleichenia hantonensis* and *Lygodium kaulfussi*. Recently spore-bearing fertile pinnules of the latter were found at Branksome Dene, as were those of an *Anemia*, *A. poolensis* (probably the fertile form of *A. subcretacea*) of which only the barren pinnules had previously been found. *A. poolensis* also occurred at Sandbanks.

Seven other fern species must be regarded as *nomina nuda*.

(1) *Podoloma polypodioides* Gardner & Ettingshausen (1879: 29, pl. 3, figs. 4–6, 9), *Phymatodes polypodioides* (Gardner & Ettingshausen) (1882: 64) regarded by Saporta as dicotyledonous whose opinion was quoted by Gardner & Ettingshausen (1879: 30, 31). Later, however, Gardner (1886: 403, pl. 3, fig. 7) figured under this same name a group of leaves, more linear than the originals, which he was unable to regard as specifically distinct. He noted that their disposition pointed to growth in a tuft on a rhizome and not as lateral pinnae, comparing them with living *Phymatodes geminatum* and other tropical American forms. He asserted that they were indubitably *Polypodium* of the section Phymatodes and they are much more fern-like in appearance than the original *Podoloma*. Nevertheless the position in regard to this 'species' remains confused and unsatisfactory.

(2) *Podoloma affine* Gardner & Ettingshausen (1879: 30, pl. 3, figs. 7, 8) more delicate and membranous than the preceding but also apparently dicotyledonous. Both these forms were found in the highest Freshwater Beds and were associated with rushes, conifers and such ferns as *Pteris*, *Osmunda* and *Acrostichum* (*Chrysodium*).

(3) *Glossochlamys transmutans* Gardner & Ettingshausen (1879: 31, pl. 3, fig. 3) later regarded as an *Acrostichum* (Gardner & Ettingshausen, 1882: 65, pl. 12, fig. 8). Both Heer and Saporta considered this 'species' a dicotyledon (cf. Gardner & Ettingshausen, 1879: 32).

(4) *Pteris bournensis* Gardner & Ettingshausen (1879: 33, pl. 4, fig. 7) found in a leaf bed near Poole Harbour was based on a single fragment which both authors regarded as of doubtful generic position. Gardner later (Gardner & Ettingshausen, 1882: 63) admitted that it was an unsatisfactory species.

(5) *Asplenites prae-allosuroides* Gardner & Ettingshausen (1879: 34, pl. 3, figs. 1, 2) found under the Coastguard station. Perhaps a fertile pinnule of *Lygodium* (Gardner & Ettingshausen, 1882: 68) although a recent examination made at the British Museum failed to release any spores.

(6) *Meniphyllum elegans* Gardner & Ettingshausen (1879: 36, pl. 3, figs. 10–14) found in the highest beds near the cliff top east of the Pier (V.14933–36, V. 15010), one specimen only occurring further west below the Watch Tower. Saporta suggested that this leaf with obscure nervation was again a dicotyledon (quoted in Gardner & Ettingshausen, 1879: 37, footnote) while Gardner himself (Gardner & Ettingshausen, 1882: 70) later admitted that it was probably not a fern.

(7) *Woodwardia? venosa* Gardner & Ettingshausen (1880: 41, pl. 10, fig. 5, 5*a*; 1882: 63) a doubtful determination based on a mere fragment (V.14976).

One other small and indeterminable fern fragment figured by Gardner (1886: 404, pl. 3, fig. 8, 8*a*) was compared with *Adiantum* and *Lindsaya* but not named.

A supposed indeterminable fragment (V.14977) figured by Gardner & Ettingshausen (1882, pl. 12, fig. 9, 9*a*) may also be a dicotyledon.

Gardner commented that the ferns were abundant east and west of Bournemouth itself but almost absent from Poole except for a climbing *Lygodium* which was common there. He also found a single fragment of *Acrostichum lanzaeanum* in that area. *Lygodium* although most abundant near Bournemouth Pier occurred throughout the Poole–Bournemouth section. *Acrostichum* was frequent on both sides of the Pier. Recently, as already mentioned, the writer has obtained fertile pinnules of *Anemia poolensis* at Sandbanks and Branksome Dene and barren fragments of *Anemia subcretacea* at the latter locality. It is therefore probable that the supposed absence or scarcity of ferns at the western end of the section may be due to some extent to the type of sedimentation. Impressions of such delicate organs as fern leaves are unlikely to be preserved in coarse sand among the seams of battered and abraded carbonaceous detritus from which *Anemia* and *Lygodium* have now been obtained by washing.

Among conifers the supposed '*Taxodium europaeum*' was recorded from the western end of the section in Gardner's '*Lygodium* and Laurel' and 'Willow' Beds but not further east; this species, now referred to *Cupressistrobus gardneri* (p. 45), is in actual fact distributed throughout the length of the section. Between 1883 and 1885 eight species of conifer were named by Gardner. In the light of Professor Florin's conifer studies (1931) it appears that in

many cases determinations based on the external characters of sterile branchlets must be regarded as of doubtful value, for he showed conclusively that these can be most deceptive as a guide to relationship unless combined with a study of cuticle structure. New information

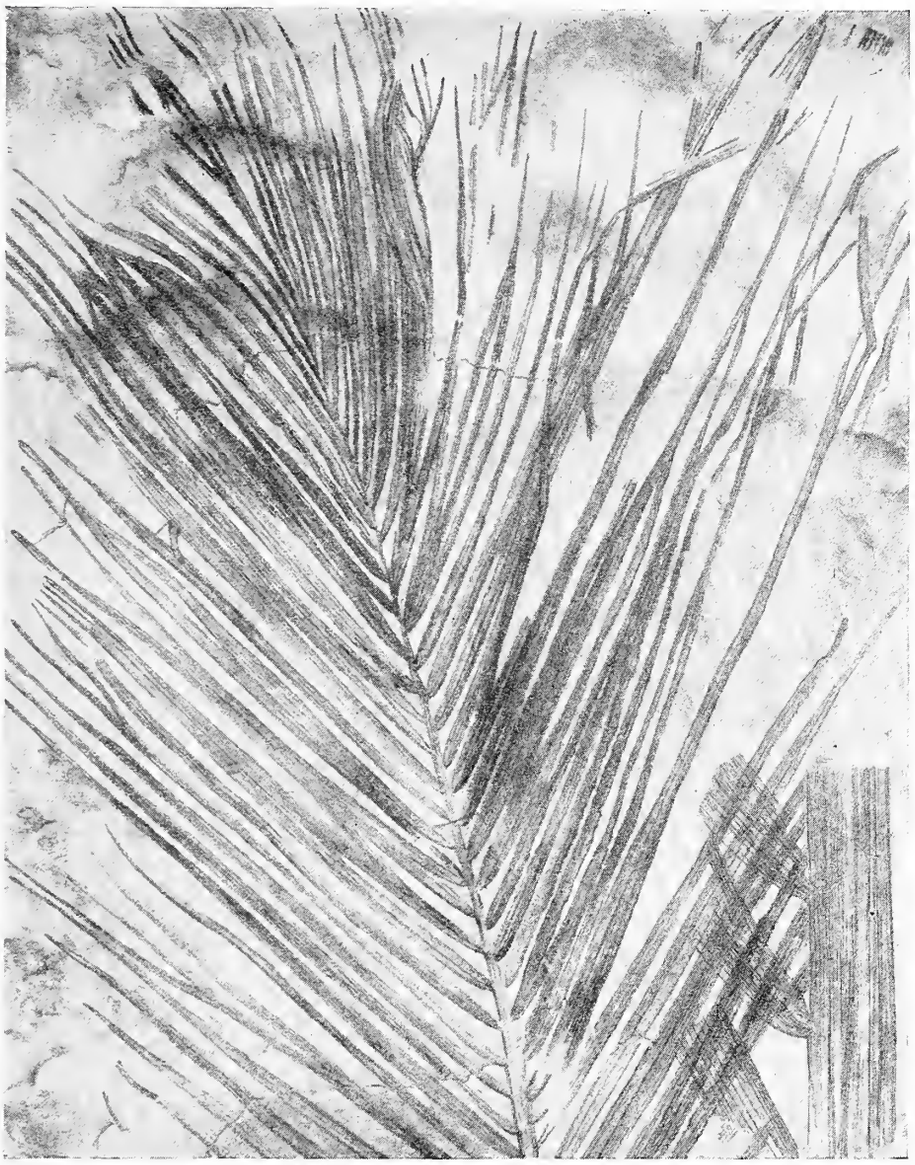


Fig. 1. Large pinnate palm leaf from cliffs at Bournemouth where palm leaves abounded. Insertion of pinnules shown below (right). See pp. 7, 72. V.16850. × 0.12. Unpublished figure after Gardner.

about some Bournemouth conifer cuticles indicates that Gardner's eight species must now probably be reduced to six. Of three the determination is supported by a limited amount of cuticle structure but in the case of the other three additional information is needed. Six species only are included in the plant list. The forms named *Sequoia tournalii* (Brongniart) and, as indicated above, *Taxodium europaeum* (Brongniart) are omitted for both clearly belong to

Cupressistrobus gardneri described by Gardner as *Cupressus taxiformis* (in part at least). Neither *Podocarpus incerta* Gardner, *P. eocenica* Unger, nor *T. eocenicum* Gardner have yielded cuticle, so their position is doubtful. *Pityolepis durleyensis* Bandulska (1923: 705, text-fig. on

Fig. 2. Distal end of a palm leaf with opposite and alternate pinnules, prominent midrib and conspicuous parallel nerves about 6 mm. apart with a number of subsidiary close-set nerves between them. V.486. × 0·2 approx. Unpublished figure after Gardner.

p. 706) shows clear dicotyledonous nervation and cannot now be regarded as a gymnosperm but appears to be some sort of bract. Gardner thought, almost certainly erroneously, that these organs were *Flemingia*, the bracts of which envelop the seeds. This opinion is shown by a statement with sketch of a bract in a rough draft of a paper on the Bournemouth Freshwater Beds in the Gardner portfolio. The draft also mentions the possibility that the organs may be the very large stipules of a serrate-leafed willow. In the published paper (Gardner, 1882: 6) the allusion to *Flemingia* does not occur but the reference to willow stipules has been incorpor-

ated. Gardner placed on record that his leaves occurred in small basins each of which contained a large proportion of species peculiar to itself. At the western end of the long stretch of coast near Poole he obtained many dicotyledonous leaves, some evergreen, others deciduous. One such basin afforded a mass of 'beech' or 'hornbeam' leaves, another the 'willow-like' leaves with stipules mentioned above. He further relates how he explored many of the little plant basins in the immediate neighbourhood of Bournemouth. One yielded an abundance of

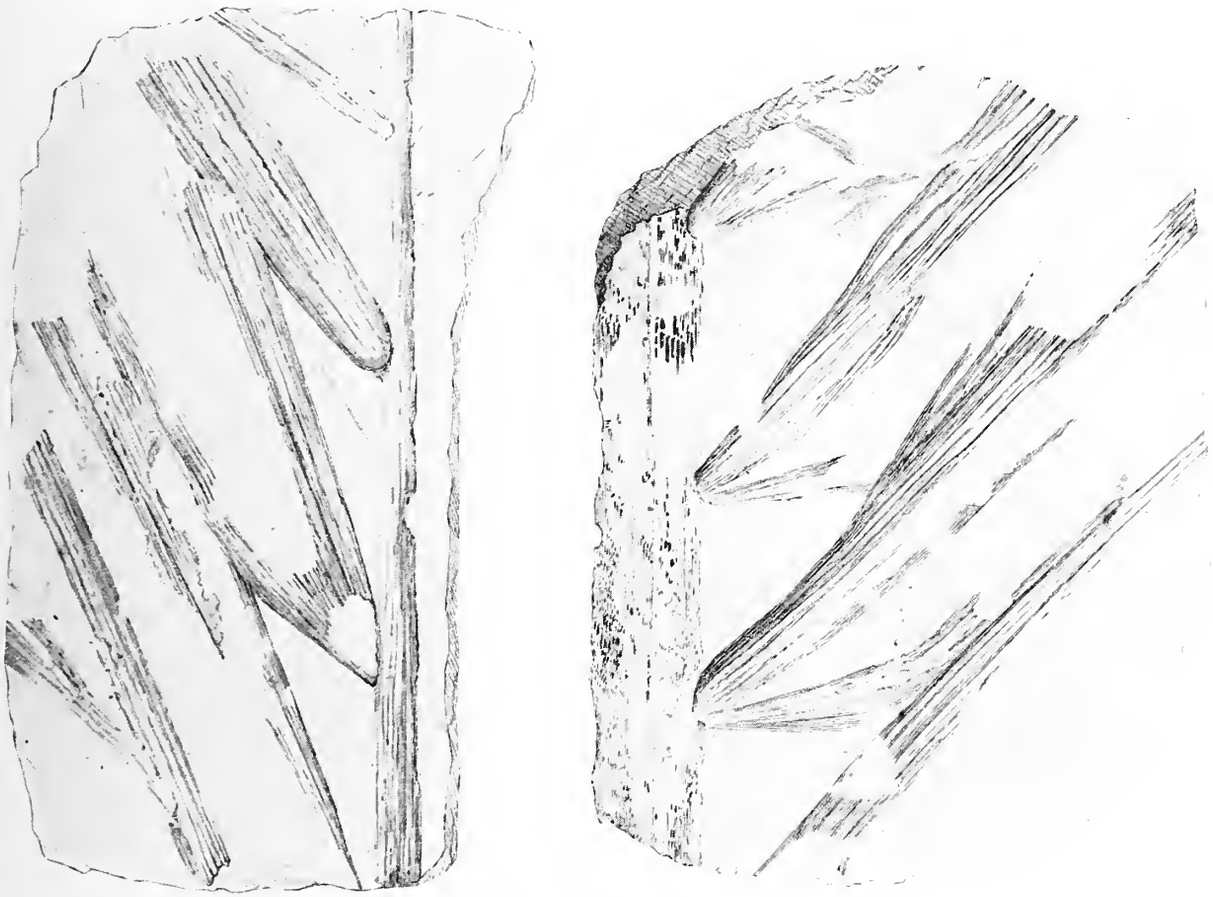


Fig. 3. Counterpart fragments of a large pinnate palm leaf with pinnules which tend to shred longitudinally throughout their length. V. 44296. ×0·6 approx. Unpublished figure after Gardner.

pinnate palm leaves. A plant basin between Great and Little Durley Chines yielded a mass of '*Myrica*' leaves, while another between Little Durley Chine and Bournemouth Pier contained *Gleichenia* together with pinnate palms and other leaves. Of such pinnate palms (cf. Text-figs. 1,2 reproduced from the Gardner portfolio) Gardner & Ettingshausen (1879: 17) stated that they appeared 'to resemble *Iriartea* more than any other genus. But of one large specimen it has later been written (Guide to Fossil Plants in the British Museum (Natural History), 1935: 61) that 'It is so like recent genera as to make identification difficult' but 'It might possibly belong to *Nipa* whose fruits have been found at Bournemouth' (cf. Text-fig. 1). Palmate leaves and inflorescences of palms (see Text-fig. 4) also occurred (Gardner & Ettingshausen, 1879: 17; Gardner, 1882: 8, footnote). Under the Coastguard station were

seven or eight layers each with its own peculiar group of leaves and with both pinnate and palmate palms of unspecified genera so unmistakably Palmae that they can be accepted without hesitation. In one layer were numerous small '*Ficus*' leaves (a genus now also known from its endocarps); in another *Osmunda*, 'Cactus' spines according to Carruthers but actually *Calamus*

Fig. 4. Fruiting spike regarded by Gardner as 'date palm'. From beds between Great Durley Chine and the Bourne Valley. See Gardner, 1882 footnote p. 8. Cf. V. 44999 × 0·5 approx. (Inset × 2 approx.) Unpublished figure after Gardner.

daemonorops (Unger) and a conifer; in another *Gleichenia*, and so on (Gardner & Ettingshausen, 1879: 17, 18). The Gardner portfolio shows numerous drawings of leaves attributed to *Smilax* and contains the MS of an unpublished paper on this genus as represented at Bournemouth.

The following are the approximate positions given for some of the most productive beds (Gardner, 1882: 4, fig. 1). The '*Lygodium*- and laurel-beds', 'Hornbeam and willow-bed' west of Sugar-loaf Chine (now Canford Cliffs Chine), and the Watch Tower. The 'Willow-bed' east of Sugar-loaf Chine and west of Branksome Glen or Watering Chine. The position of the '*Myrica*-bed' and '*Gleichenia*-beds' have already been indicated.

The abundant vegetation in the immediate neighbourhood of Bournemouth suggested to him the luxuriant growth of a tropical valley whereas the ferns and rushes to the east of the Pier indicated a swamp or marsh where 'aroids', fan palms, 'eucalyptus' and conifers were interpreted as evidence of moisture and shade.

It is indeed unfortunate that the numerous angiosperms mentioned in early publications are not yet firmly established for they are neither figured nor described although in some cases they are represented by drawings and lithographs in the Gardner portfolio. To summarize: in addition to palms there are said to be *Populus*, *Carpinus* (supported by recently discovered fruits), *Flemingia* (probably incorrectly identified as suggested above), *Myrica*, *Godoya*, *Ficus* (also supported by recently discovered endocarps), the so-called 'Cactus', *Eucalyptus*, *Stenocarpus*, an *Acacia*-like leaf, leguminous pods, *Diospyros*, *Smilax*, *Cecropia*. There were also unnamed 'rushes' (Gardner & Ettingshausen, 1879: 17, 18) and a casual mention of twenty-two undescribed species of dicotyledon (Gardner & Ettingshausen, 1879: 14). Bandulska in a series of short papers (1923–31) determined a few angiosperms from leaves which yielded cuticle. Her determinations belong largely to different genera from those so far recognized among the fruits and seeds. The discrepancies between the results afforded by the two branches of study were discussed by Reid & Chandler (1926: 10–13) who believed that the differences were due to differential buoyancy and durability of these organs during transport. Naturally the cuticle determinations include a high proportion of plants with tough resistant leaves and cuticles. Bandulska recognized a number of Lauraceae and pointed out that the physiological characters of those cuticles she described are associated at the present time with the need for controlling transpiration. She instanced such features as depressed stomata, protection of stomata by scales, the presence of accessory cells forming a vestibule, or of hairs, the thickness of the cuticle and the presence of spicules (Bandulska, 1926: 420). It is possible that some of her work now needs revision and her determinations are not included in the plant list as leaves do not really come within the scope of this monograph. The presence of Lauraceae and, in particular, of *Cinnamomum*, is also supported by the finding of fruits. It may be noted in passing that Bandulska recorded five Lauraceae genera viz. *Aniba*, *Cinnamomum*, *Neolitsea*, *Litsea* and *Lindera* among the small amount of material she was able to investigate.

5. RECENT FINDS OF FRUITING ORGANS

The successive new sites from which fruiting organs have been obtained in recent years will now be described beginning at the western, oldest end of the section.

(i) Sandbanks

(National Grid Reference 30/052886)

To the east of Poole Harbour a rich lignitic lenticle was discovered in 1936 in the cliff face near Shore Road, Sandbanks and a short distance west of Simpson's Folly (the name given to a conspicuous low bluff crowned by concrete slabs marking the site of a house built many years ago). The lenticle overlay about five feet of dull purplish laminated silt forming the base of the cliffs. In the silt were scattered quartz grains and numerous thin, fine carbonaceous seams. The compact tenacious character of the matrix had caused it to be sharply delimited from overlying coarse uncompacted sands, readily removed by subaerial denudation,

beyond which it projected. Both the texture of the clay and the regular seams of fine vegetable detritus suggested deposition in still water marking the site of a stagnant lagoon or lake. Abundant cuticle fragments, decayed *Scirpus* fruits and seeds of an extinct genus of Lythraceae, *Palaeolythrum*, were found on sifting the matrix. They were associated with *Rhamnospermum bilobatum* of such common occurence among aquatic vegetation. All were much compressed and macerated and retained only the inner integuments. The same sediments and organic remains form the prominence of Simpson's Folly.

The productive lignitic lenticle lay immediately above the silt. It was a conspicuous matted mass of twigs, wood, fruits and seeds all readily separable from a sandy matrix of angular quartz grains. The fossils and wood were crushed and in some cases much shrunken and distorted but better preserved than the comparable material in the Lower Bagshot Beds of Lake. They also appear less heavily pyritized and therefore less liable to decay than specimens of similar appearance from the Lower Headon of Hordle. On a first visit to the section the lenticle was at least twelve feet long and its maximum thickness about two feet. A subsequent visit revealed the lenticular character for erosion had by then reduced the length to a couple of feet. Later still it had completely disappeared and when the section was again visited after the war the site was obliterated by concrete steps. Above the plant pocket and extending to the surface soil were barren sands.

(ii) Branksome Dene

(National Grid Reference 30/075092)

About a mile and a half east of Sandbanks lies the wooded ravine known as Branksome Dene. On the eastern side of its mouth there was an exposure of fine soft lignitic sand which was seen in the undercliff above the sea wall. The section appeared to be that of a stream channel (cf. p. 2) and showed fine carbonaceous layers with fruits and seeds belonging to a limited number of species. A band of coarse angular grit formed a conspicuous ledge in the cliff face overlying the productive seams. The best plant remains came from a well defined lignitic layer capping a bastion of cliff some six to seven feet above the sea wall. The site was easy to locate because an agglomerated mass of angular lignitic fragments formed a two- to three-inch thick black band between it and the ledge of grit. Unfortunately this black band yielded only indeterminable small angular wood fragments. Finer silty strata with carbonaceous streaks a few feet above the sea wall to the east furnished only a few species. Almost all the specimens from Branksome Dene were much compressed and appeared very thin as if they had been exposed to prolonged but gentle maceration under water. Otherwise their preservation was similar to that of the Sandbanks finds. Owing to the gentleness of the processes of decay evidence was preserved here in a few instances which had been destroyed at other sites. For example the outer integument was still present in *Palaeolythrum* and a group of seeds lay in the position of growth still attached to part of a septum in *Microdiptera*.

(iii) Other localities nearer Bournemouth

Immediately after the war, samples of carbonaceous beds were taken for examination from various points between Alum and Durley Chines. Also some fallen blocks collected before the war by Bandulska were examined for fruits and yielded a few specimens.

(a) In fallen blocks chiefly between Canford, Branksome and Durley Chines a few scattered and isolated fruits were found by Bandulska. A few specimens were also received from Mr. F. M. Wonnacott.
(b) A sample collected by the writer between Alum and Middle Chines yielded sparse fruits and seeds.
(c) A short distance west of Alum Chine a few specimens were obtained near the cliff base from the section, mentioned on p. 2, exposed by storm damage.
(d) Between Middle and Durley Chines a few fruits were found in a ferruginous false-bedded coarse sand full of lignite fragments, mostly angular chips of wood quite undeterminable.
(e) A sample from a finely laminated leaf bed yielded no determinable fruits or seeds.

Taking the flora as a whole the proportion of ferns and conifers to angiosperms may appear unduly large owing to the fact that much work on the ferns and conifers was finished by Gardner whereas his research on the angiosperms was never published or even completed. Moreover, as already pointed out, recent workers have had but few opportunities of redressing the balance by a corresponding amount of collecting to that carried out by him.

6. FRUIT IMPRESSIONS FROM THE GARDNER COLLECTION

A considerable number of fruit impressions, especially leguminous pods, are still preserved in the Gardner Collection. Unfortunately they are not fully localized and it is fairly certain that although they are alleged to come from 'Bournemouth' this name was used rather loosely to cover the whole area so that it includes specimens from the Dorset Pipe-clay Series in the west, the Bournemouth Freshwater Beds in the centre and the Bournemouth Marine Beds in the east. It is certain that Gardner himself used the term 'Bournemouth Flora' in this generalized manner in a paper on the Lower Bagshot Beds (1877: 51). For the present, therefore, these impressions have been left on one side for further research and publication in a separate *Bulletin* paper. There is some hope that it may yet be possible to determine to which horizon some of this material belongs. A few such impressions have been described by Chandler (1962: 163-167, pl. 28, figs. 6-10; pl. 29 figs. 1-23).

It may be noted in passing that Gardner writing about the Alum Bay flora (*in* Reid & Strahan, 1889: 106) comments on 'the large leguminous pods which give the Lower Bagshot Flora its tropical aspect' in the Dorset Pipe-clay Series at Studland and Creech Barrow. He also mentions 'leguminous pods' (not specified as large) in a patch of drab and pinkish clay '100 yards to the east of the Branksome Watch-tower' and in the Coastguard Beds (1882: 6, 9) i.e. in the Bournemouth Freshwater Beds, and again near the junction of these beds with the Marine Beds east of the Pier at Bournemouth (Gardner, 1879: 225).

B. The Marine Beds between Bournemouth East Cliff Lift and the base of the Bartonian at Cliff End near Mudeford

1. INTRODUCTION

The plant-bearing strata which lie between the Bournemouth Freshwater Beds and the base of the Bartonian are described by the Geological Survey as Bracklesham Beds (White, 1917: 28).

Unlike the more truly marine deposits further east in the Selsey area which can be referred to the continental stages of Cuisian, Lutetian and Auversian on the evidence of *Nummulites* or other marine fossils, these beds, although laid down in part at least by a transgressing sea yield no indubitable well-preserved marine fossils by which they can be dated and as in the case of the Bournemouth Freshwater Beds and the Dorset Pipe-clays the boundaries of the stages recognized on the Continent are again not clearly distinguishable. The Marine Beds appear in part to succeed and in part to take the place of the Freshwater Series near the East Cliff lift at Bournemouth as will be described. They are followed eastwards by the Boscombe Sands. The gap at Christchurch Harbour and Double Dykes conceals the relationship of these Sands to the beds of Hengistbury Head on the one hand and to those of the cliffs east of Christchurch Harbour on the other.

The pockets of plants which appear at intervals throughout the coast section from the older Pipe-clay Series of Dorset to the latest Bracklesham at Cliff End in Hampshire have a number of genera and species in common yet there appears to be some slight evidence of gradual change in passing from the freshwater 'Lower' and 'Middle Bagshot' in the west to the so-called 'marine' Bracklesham Beds or Bournemouth Marine Beds in the east. The plant evidence cannot at present indicate where the boundary between the Lutetian and Auversian should be drawn. In such a continuous sequence no well defined lines of demarcation are to be expected for floras change slowly and no spectacular breaks in the plant sequence are likely to have occurred while conditions of temperature and humidity remained constant. On the whole the biological and ecological background of plant life seem to have varied little during the time which elapsed while the whole of the Bournemouth Beds (freshwater and marine), Boscombe Lignites and Highcliff Sands were being deposited as indicated by the number of species common to the different sites. A few new species appear which are absent in the older sections, a few also have disappeared in the newer sections so far as evidence goes. But some at least of the differences observed may be explained by small differences in the immediate and local sources from which specific plant sites and pockets happen to have come. The absence of certain plants and the presence of others may indeed be fortuitous and without chronological significance. Each plant pocket is in fact such a random sample of the flora it represents that the greatest caution must be exercised in deducing conclusions from its composition. Perhaps the boundary between the Lutetian and the Auversian may be indicated by the beginnings of marine transgression seen in the Bournemouth Marine Beds, continued in the Highcliff Sands and later becoming more marked in the deep-water deposits of the Bartonian.

2. CLASSIFICATION OF THE BRACKLESHAM BEDS OF THE BOURNEMOUTH AND CHRISTCHURCH AREA

The Bracklesham Beds as described by the Geological Survey include the following four divisions:

The Highcliff Sands (Cliff End Beds)
The Hengistbury Beds
The Boscombe Sands
The Bournemouth Marine Beds (oldest).

There has been much difference of opinion as to the relationship of the Hengistbury Beds to the beds of the mainland and of the Highcliff Sands to the Boscombe Sands. For reasons

indicated by Chandler (1961 : 8, 9) the flora of the Hengistbury Beds has already been described together with that of the Barton Beds (Chandler, 1960) and its consideration is therefore omitted here but the other three stages are dealt with in this monograph. Throughout these stages there is sporadic evidence in seams or rafts of plant remains, scattered vegetable débris and fine carbonaceous matter of copious drainage from a nearby land surface. The beds were laid down, largely under marine conditions owing to a movement of slow subsidence which allowed the sea to transgress from the east so that in part the Bournemouth Marine Beds overlap the Bournemouth Freshwater Series although in part they take their place. The abundance of *Nipa* at Honeycomb Chine and its reported occurrence about 550 yards east of the East Cliff lift and west of Boscombe Chine (White, 1917: 31; Gardner, 1879: 222) must certainly indicate a tidal swamp at no great distance. A palm stem was noted by Gardner washed from older beds at Poole with white clay entangled in its roots (1879*a*: 150); a short distance east of Honeycomb Chine *Calamus daemonorops* was found, while '*Dryandra*' and *Araucarites* were abundant at the east corner of Boscombe Chine (Gardner, 1879: 221; 1879*a*: 150). The Bournemouth Marine Beds perhaps represent the seaward facies of the deltaic Freshwater Formation into which they pass laterally in some sections (see below) although in others, as mentioned, they overlie the Freshwater Series (cf. Gardner, 1879: 223–4; Ord, 1914).

If the dating adopted following Wrigley & Davis (1937: 220, pl. 18) is correct the Lutetian may be presumed to include those Marine Beds which pass laterally into the Freshwater Series whereas the transgressing Bournemouth Marine and successive Beds up to the well dated Bartonian A1 of Barton cliff (Burton, 1933) must then represent the Auversian. The Bartonian marks the onset of deeper water conditions, indicated by the Barton Clay.

3. CONSIDERATION OF SUCCESSIVE BEDS IN GREATER DETAIL WITH ESPECIAL REFERENCE TO PRODUCTIVE SECTIONS

(i) The Bournemouth Marine Beds

Lower Marine Beds of Gardner, 1879*a*: 149.

(*a*) *Gardner's Account*

The evidence of a lateral passage of the Freshwater Beds into the marine and brackish delta muds was seen and published by Gardner (1879: 223–225; 1879*a*: 149–150) who interpreted the section as indicating the actual delta mouth where there was marked tidal action. Some of the beds he claimed as marine with marine shells, others estuarine with a freshwater fauna, *Unio*, shore crab and Bryozoa. Yet others were freshwater beds with ferns. Among the Bryozoa was the genus *Diachoris* now living in the Mediterranean, but more common in the southern hemisphere. Gardner's section is unfortunately no longer exposed and even in his day had to be cleared by extensive excavation but he noted that the Bournemouth Freshwater Series was completely replaced laterally by the marine beds within about 100 yards. His section showed the fern beds contracted and distorted and finally pushed upwards into a point and displaced by a wedge of hard sand which thickened rapidly to form a perpendicular cliff about forty feet high, filled with lumps of clay representing the broken remains of the fern bed.

(*b*) *Ord's Account*

Many years after Gardner had published the above record, Ord (1914) described the most easterly section of the Freshwater Series then exposed. These beds disappeared below beach level just below the cliff lift east of Bournemouth. At the same place the Marine Beds were observed at the top of the East Cliff and were traced eastward to Southbourne until they disappeared below beach level a few yards beyond the site of the former pier. The seemingly contradictory observations of Gardner and Ord, taken together, suggest that there was a lateral passage from Freshwater to Marine Beds in part of the section, while in part the Marine Beds were superposed on the Freshwater owing to westward encroachment of the sea. Indeed Gardner actually states that the change from marine to freshwater (he described the section from east to west) was due 'partly to the rise of lower beds and partly to the passage into the Freshwater beds' (1879: 223).

(*c*) *General Characteristics*

In the Marine Beds leaves, twigs, fruits and seeds and drifted and *Teredo*-bored wood have been reported and finely comminuted carbonaceous matter imparts a dark colour to the clays and sands. There are also occasional rootlet beds indicating marshy stretches of ground. Within short distances the beds may change continually from dark sandy clays to buff and yellow or white sands. Sometimes the dark clays are represented by a mere line, or by lenticular patches. In black sandy clays Gardner recorded oysters and leaves covered with Bryozoa. He also noted casts of shells alleged to be Bracklesham species. Among these were the genera *Modiola*, *Tellina*, *Natica*, *Cerithium* and *Unio* also quoted by Ord (1914: 123). Fragments of calcareous shells were found recently in a dark sandy much current-bedded deposit with pockets of carbonaceous matter and broken wood some seventy to eighty yards east of the East Cliff lift. This site yielded a few seeds on sifting.

(*d*) *New Localities containing Identifiable Plants*

(*i*) *Section east of the East Cliff Lift, Bournemouth.* This section (mentioned briefly above) is the most westerly plant bed now exposed and is about seventy to eighty yards east of the East Cliff lift. The beds where they were accessible lay a few feet above the low promenade wall on the Undercliff Drive near the base of the cliff. Small samples only could be obtained by sifting which yielded minute fragments of young twigs of *Cupressistrobus gardneri* (identified by its cuticle), fruits of *Caricoidea angulata* and *Caricoidea obscura*, seeds of *Stratiotes hantonensis*, *Hantsia pulchra*, *Cleyera*? *stigmosa* and endocarps of *Eomastixia rugosa* (Zenker). A much larger number of plants could probably be obtained from this site if working on the cliff face were allowed. The Undercliff Drive now unfortunately hides rich pockets of fruits formerly reported near the base of the cliff and presumed to belong to the underlying Freshwater Beds.

(*ii*) *Honeycomb Chine Sands, Boscombe* (National Grid Reference 30/113912). The deeply excavated hollows known as Honeycomb Chines, just east of Boscombe, are perhaps the best-known localities for plants in the Bournemouth Marine Beds. Here the cliffs are formed of peculiarly soft sand readily washed away by heavy rains. *Nipa* fruits have always been abundant, occurring especially in the eastern and western sides of the Chine and in a flat platform which forms the surface of the undercliff at the south-east corner. Rain frequently

washes away the surrounding sand leaving the *Nipa* fruits projecting conspicuously when they can be collected in fair numbers. The fruits and seeds are preserved as sandy casts held together by a thin film of decaying carbon. Their softness and liability to crumble make them difficult to extract whole or to keep indefinitely. Smaller, less conspicuous fruits are scattered rather sparsely through the sands but are easily overlooked. If the sand could be sifted on the spot a considerable number of plants would undoubtedly be added to the small list from this locality. *Araucarites*, *Stratiotes*, *Cleyera*?, *Rhamnospermum*, *Eomastixia* and *Mastixicarpum* are among the commoner types. Gardner (1879: 222, 223) mentioned *Hightea*, *Cucumites* and *Petrophiloides* some distance west of Boscombe Chine but gave no figures or descriptions and there is no recent evidence of these genera. It is quite possible that his *Petrophiloides* may have been a fruiting head of *Protoaltingia* not uncommon here in an abraded condition. Gardner (1887: 249) recorded that Elwes in excavating in the New Forest met with '*Nipadites*' in abundance but no horizon or locality are named. The species was said to be identical with that from Bracklesham Bay, but entirely different from the Honeycomb Chine specimens [!]. However Reid & Chandler (1933: 119) refer fruits from both Bracklesham Bay and Honeycomb Chine to *Nipa burtini* and a single species of *Nipa* appears to have persisted throughout the London Clay and succeeding warm periods. Other examples of plants with a long Tertiary range are *Sequoia couttsiae* Heer, *Rubus acutiformis* Chandler, *Acrostichum lanzaeauum* (Visiani) and *Natsiatum eocenicum* Chandler.

(*iii*) *Dark sandy clays, cliff base, Southbourne* (National Grid Reference 30/122913). The dip of the strata brings the uppermost beds of the Bournemouth Marine Series near to the cliff base at Southbourne. Here the beds of hard sand are somewhat ferruginous and often indurated as the result of the action of salt water upon them. In 1938 parts of the upper surface were exposed by scouring action of the sea along the bedding plane east of the termination of the Undercliff Drive but only a few species were found, for remains were sparse and the hard sand did not readily disintegrate.

(*iv*) *Laminated Leafy lenticle near the cliff base at Southbourne.* A few species were obtained by washing samples of a finely laminated lenticle of compressed and matted fragmentary leaf remains from the cliff base a few yards west of the wooden stairs which led from the foreshore to the cliff top in 1938. Many fragments of leaves and cuticle were obtained as well as a few fruits and seeds. The Undercliff Drive was then under construction at this point and the productive seam is no longer exposed.

(ii) The Boscombe Sands: their General Character and the Distribution of Carbonaceous Rafts at the Base and Top of the Series

Upper Marine Series of Gardner, 1879*a*: 150.

Above the sporadically fossiliferous 'Marine Beds' are the Boscombe Sands hitherto considered virtually barren. The junction of the two can often be traced by a line of moisture which, according to Gardner (1879*a*), darkens the Marine Beds superficially even when they were originally white. The Boscombe Sands are yellow and white with rolled shingle banks. The pebbles are white coated, rounded and worn. Few of the strata are continuous for any distance and there is much current bedding. E. St. John Burton found thin seams of pink

clay with leaf impressions (ex lit. 23.9.48). The Sands may have originated as sandbanks associated with the old river channel, or more probably may be deposits of the transgressing sea. Burton considered that they were formed off shore 'a littoral deposit with masses of rounded flint pebbles of Eocene age' (ex lit. 27.9.45). They may mark the landward migration of bars and shoals during the subsidence which took place while the Bracklesham Beds were being formed (White, 1917: 33). The upper beds of the Boscombe Sands give evidence of more tranquil conditions. They appear to have been laid down in deeper water, the bedding is more regular and seams of sandy clay occur. Gardner describes the upper beds as indicating that the prevailing set of the tides was often changed and the lower as showing the infilling of channels parallel with the shore (1879: 218). Stamp (1921: 56) interpreted these beds as subaerial shingle banks marking a retreat of the sea between the Lutetian and Auversian, placing the boundary between these two periods higher in the coast section than the position adopted in the present work at the base of the transgressing Bournemouth Marine Series. Carbonaceous pockets or rafts of vegetation were found in the Boscombe Sands about six to eight feet above the hard sandy clays of the Marine Beds seen at the base of the cliff. The pockets were dark in colour, crowded with woody fragments embedded in purplish-black loose-textured sandy matrix. A pocket about a quarter of a mile east of the wooden stairs to the beach was examined by sifting and yielded a few fruits and seeds.

Immediately overlying the Boscombe Sands, preserved only for a short distance below the Pleistocene gravel which caps the cliffs, is a thick compact layer of lignite with fruits and seeds (National Grid Reference 30/129913). The layer, normally out of reach in the high and crumbling cliff section, had previously been overlooked but in 1944 and 1945 it became conspicuous owing to falls from the cliff top. On account of its dark colour it forms a conspicuous feature in the cliff. Possibly it may be merely an impersistent lenticle then recently sectioned by the receding cliff. The greatest thickness of the high cliff face was formed by current-bedded whitish sands with thin indurated iron-stained bands. In the upper part of the section the sands became lighter in colour. Above them was a conspicuous band of coarse much rounded pebbles varying from about six to twelve feet in thickness and immediately overlain by two or three feet of fine, much iron-stained pebbles. Next several feet of a dark grey or black bed formed a projecting ledge at the time of investigation. This was the lignitic raft under consideration. Examination of fallen blocks showed it to be crowded with abraded and battered, sodden, woody fragments much rotted and compressed and sometimes *Teredo*-bored, together with some fruits and seeds. There was a matrix of coarse white grey or bluish sand. On drying, the bed and its contents crumbled and formed ashy blue-grey masses of unrecognizable débris. About a hundredweight of freshly fallen material was removed for examination, boiled and sifted. The seeds and fruits were so rotted through long maceration in water during the formation of the deposit that it was difficult to extract them whole or to preserve them when extracted. The process of cracking and shattering on drying was hastened by decay of the pyrites with which all the carbonaceous matter was impregnated. The plant remains in the bed appeared to have been pounded together, the fruits and seeds being closely adherent to pieces of wood, sometimes even embedded in them indicating that the wood must have become soft and pulpy. The obvious explanation is that after long drifting the vegetation became waterlogged, sank and was buried in sand.

The outcrop of the lignite band was of limited extent. It appeared first at the end of the

Undercliff Drive (as it was in 1945). It then extended east for about 285 paces as a shallow basin seen in section, disappeared for about 390 paces (owing partly to the diminished height of the cliff which cut it out) but reappeared again to form another shallow basin extending for about 100 paces. After this it could no longer be traced. Presumably it was either cut out by the lowering of the cliff top or had merely thinned and died out eastwards.

There appear to have been relatively few recognizable species, but some of those which occurred were abundant. Dominant were *Sequoia* (twigs), *Protoaltingia* (fruiting heads), *Thymelaeaspermum* (shattered seed fragments), an unidentified fruit valve *Carpolithus apocyniformis* (also found frequently at Hordle), *Stratiotes hantonensis* (seeds). There were also small fragments of a battered leaf of a tiny fan palm. Similar leaf fragments were stated by Ord (1914: 124) to have been abundant in the Marine Beds below the Boscombe Sands but he gave no figures or descriptions of his material which has not been traced and would almost certainly have rotted. Ord alludes to them as 'probably *Sabal*'. It seems likely that a single species may have been represented at the two stages.

The perishable condition of these fossils makes it most important to publish a photographic record. Unfortunately the drying necessary for photography often caused them to become distorted and even to disintegrate which demonstrates that ultimate disintegration will be the fate of most of the specimens from this horizon.

This lignite was almost the highest bed represented in the Southbourne cliff section. It was overlain by up to twelve feet of uncompacted whitey-brown sand preserved only where the cliff was highest, elsewhere cut out beneath the surface soil and vegetation of the cliff top. No hardened iron-stained seams were seen in these beds, and in dry, windy weather the sand poured like a cascade over the ledge formed by the lignite.

(iii) Highcliff Sands or Cliff End Beds, near Mudeford

(National Grid Reference 30/197929)

As stated on p. 12 the Boscombe Sands are separated by the gap at Christchurch Harbour from the cliffs to the east in Christchurch Bay. But at Cliff End, near Mudeford plant beds occur which if the classification on p. 13 be adopted must be regarded as almost the highest Auversian Beds of the coast section. They are succeeded conformably by sands and pebble beds and then by beds with *Nummulites prestwichianus* referred to Horizon A1 of the Bartonian. The plant remains were found in the cliff section a short distance east of Steamer Lodge. As long ago as 1849 Prestwich (pp. 43–49) had noticed plants in these beds but they had never been investigated. Their presence was indicated by a purplish tinge due to finely disseminated carbonaceous matter in the wet sandy clay. Close inspection of the cliff face showed minute fragments of *Sequoia* twig in thin discontinuous and inconspicuous dark seams. Samples of matrix were taken for examination and the section was repeatedly visited in 1933 and 1934. During this period the outflow of the River Avon (known as 'the Run') lay parallel with the coast, while east of Steamer Lodge the river was undermining the cliff face causing repeated falls of material which provided fresh surfaces and made collecting easy. To have obtained the sparsely scattered plants from the hard cliff surface *in situ* would have been a most difficult task by ordinary methods of collecting (i.e. short of digging with hired labour). The fresh blocks were subjected to a preliminary washing on the spot and some hundred-

weights of matrix were taken home for further treatment. A small representative collection of plants was thus laboriously made.

On 25 February, 1935, a diversion of 'the Run' put an end to any profitable collecting. The sea breached the right bank of the river about a mile and a half from the bar at its mouth, the water then flowed straight out to sea and the swift current no longer scoured the base of the cliff (see Burton, 1931: 157–174). As no further extensive cliff falls occurred collecting ended.

The section from which the plants were obtained has been described in several publications, the succession of beds given being in close agreement in them all although differing in minor matters such as the thickness and number of sub-divisions. At the top of the cliff are the unmistakable green glauconitic sands and clays of the Barton Beds including Burton's Horizon A1 with *Nummulites prestwichianus* (*elegans*) (Burton, 1933: 134). Below them was a conspicuous band of well rounded quartz pebbles. Below again hard white compacted sands with an abundance of small angular quartz pebbles. These overlay the light coloured and white sands of the plant beds, which formed the middle and lower part of the cliff section. The plant-bearing sands were fine, compact, hard and difficult to disintegrate whether wet or dry. They were numbered 2 and 3 in a section published in the Geological Survey Memoir (White, 1917: 37). In an account of the Barton cliffs (Curry, 1937, pl. 19) they were described as white sands of doubtful origin. The scanty molluscan fauna of these beds was said to be of Bartonian aspect (Burton, ex lit. 10.11.37).

It is unfortunate that Nummulites were very scarce at this horizon. While sifting the sands for fruits and seeds four rather poorly preserved pyritized internal casts of Nummulites were found. They were examined by Curry who reported as follows in a letter dated January 1941: 'The specific characters shown by the specimens are very interesting, but unfortunately ambiguous when related to living forms. The relation of diameter to thickness is one of the easiest criteria, and on this basis they are intermediate between *N. variolarius* (Auversian) and *N. rectus* (Barton A3). I have never found free pyritized *Nummulites* before'.

A small bivalve obtained at the time was said by L. R. Cox to be 'much too minute to be determinate, although it seems to belong to the family Veneridae, possibly to the genus *Meretrix*. It is certainly marine.'

Before the diversion the scouring action of 'the Run' at the base of the cliff also exposed on the foreshore at low water beds which have rarely been seen and with the building of a stepped promenade at Mudeford in recent years it is unlikely that they will be visible again. They were coarse, dark, iron-stained sands (purple when unweathered) hardening on exposure into thin ironstone masses of uneven thickness and irregular surface. Many years earlier also when 'the Run' had followed a course close to the cliff, Gardner had seen and described the same dark beds (1879: 211; cf. also White, 1917: 37). He correlated them with the top of the Hengistbury Beds and in his opinion they constituted a most important link between the mainland section and those of Hengistbury and gave grounds, he thought, for placing the Hengistbury Beds below the Bartonian. To the writer, these dark, iron-stained sands did not appear to resemble the Hengistbury Beds lithologically in any degree. The ironstones were different in texture, form and character from those of the Upper Hengistbury Beds with which Gardner correlated them. Moreover after unusually good opportunities of studying the ironstone beds *in situ* afforded by the deep scouring of 'the Run' in 1933 and 1934, it appears

probable that the beds numbered '1' in the Survey account (White, 1917: 37) were merely a duplication of beds numbered '2' and '3' (lower part) an opinion with which White seems to have concurred as indicated by a footnote on p. 37. This was also suggested by the relative positions of the two sections in the cliff face given by Gardner (1879: 211).

The dark iron-stained beds were full of pockets of wood, both large and small fragments, all much pitted and *Teredo*-bored but they yielded also a few fruits and seeds: *Scleriocarya tribrachteata* (Cyperaceae), *Stratiotes hantonensis*, *Eomastixia rugosa*. There is no reason to think that the flora differed from that of the overlying beds.

C. Plant Lists from the Bournemouth Freshwater Series and Succeeding Beds

The more doubtful ferns and conifers and casually mentioned angiosperms are omitted. Details of the precise localities from which the remains were obtained are not repeated here as they are recorded in the systematic section of this work on pp. 30–159.

In each list plants known also from older and younger horizons are marked with three asterisks. Those known also from older horizons only have two asterisks and those which appear also at younger horizons but are not yet recorded from older beds have one asterisk. The absence of an asterisk indicates that the plant is restricted at least in England to the one horizon at which it is listed so far as present knowledge goes.

1. BOURNEMOUTH FRESHWATER BEDS

Family	Genus and species
Pteridophyta	
Filicales	
Polypodiaceae	*Goniopteris bunburii* (Heer)
	Pteris eocenica Gardner & Ettingshausen
	*********Acrostichum lanzaeanum* (Visiani)
	Hewardia? *regia* Gardner & Ettingshausen
	Adiantum apalophyllum Saporta
	Adiantum sp. (?)
Gleicheniaceae	*Dicranopteris hantonensis* (Wanklyn)
Osmundaceae	**Osmunda lignitum* (Giebel)
Schizaeaceae	
Lygodieae	*********Lygodium kaulfussi* Heer
	********Anemia subcretacea* (Saporta)
	*********Anemia poolensis* Chandler
Gymnospermae	
Coniferales	
Araucarineae	**Araucarites sternbergi* Goeppert
Taxodineae	*********Sequoia couttsiae* Heer
	Taxodium? *eocenicum* Gardner
Cupressinaceae	*********Cupressistrobus gardneri* Chandler
	Podocarpus? *incerta* Gardner
	Podocarpus? *eocenica* Unger
Angiospermae	
Monocotyledones	
Potamogetonaceae	**Potamogeton pygmaeus* Chandler

Family	Genus and species
Alismaceae	?*Alisma* sp.
Hydrocharitaceae	**Stratiotes hantonensis* Chandler
	Stratiotes minutissimus n. sp.
Cyperaceae	
Scirpoideae	****Scirpus lakensis* Chandler
Caricoideae	****Caricoidea obscura* Chandler
	**Caricoidea angulata* n. sp.
Palmae	
Lepidocaryinae	
Calameae	****Calamus daemonorops* (Unger)
Corypheae	****Sabal* sp.
	Genera?
Dicotyledones	
Betulaceae	*Alnus poolensis* n. sp.
Moraceae	*Morus poolensis* n. sp.
	****Ficus lucidus* Chandler
	**Becktonia hantonensis* Chandler
	Genera?
Nymphaeaceae	***Palaeonymphaea eocenica* Chandler
	Genera?
Menispermaceae	*Palaeosinomenium hantonense* n. sp.
Magnoliaceae	***Magnolia* sp. (?*M. angusta* Reid & Chandler
Anonaceae	*Anonaspermum* sp.
Lauraceae	*Cinnamomum* sp.
	Laurocarpum sp.
Capparidaceae	*Capparidispermum poolense* n. sp.
Hamamelidaceae	****Protoaltingia hantonensis* Chandler
	Genus?
Rosaceae	****Rubus acutiformis* Chandler
?Leguminosae	Genus?
Rutaceae	****Phellodendron costatum* Chandler
	****Rutaspermum excavatum* Chandler
Burseraceae	****Palaeobursera lakensis* Chandler
Euphorbiaceae	*Euphorbiotheca* spp.
Anacardiaceae	?*Rhus* sp.
	***Spondiaecarpon operculatum* Chandler
Icacinaceae	****Natsiatum eocenicum* Chandler
Sabiaceae	***?*Meliosma sheppeyensis* Reid & Chandler
Vitaceae	***Vitis pygmaea* Chandler
	Vitis spp.
Tiliaceae	?*Tilia* sp.
Dilleniaceae	**Actinidia eocenica* n. sp.
	***Actinidia poolensis* n. sp.
Theaceae	
Taonabeae	****Cleyera*? *stigmosa* (Ludwig)
	****Hordwellia crassisperma* (Chandler)
Flacourtiaceae	****Oncoba rugosa* Chandler
Lythraceae	*Microdiptera major* n. sp.
	**Palaeolythrum bournense* Chandler
Nyssaceae	****Nyssoidea eocenica* Chandler

Family	Genus and species
Cornaceae	
Mastixioideae	***Eomastixia rugosa* (Zenker)
	***Mastixicarpum crassum* Chandler
Cornoideae	**Dunstania glandulosa* (Chandler)
Symplocaceae	***Symplocos headonensis* Chandler
Oleaceae	*?*Olea headonensis* Chandler
Solanaceae	***Solanispermum reniforme* Chandler
Caprifoliaceae	*?Abelia* sp.
Incertae Sedis	***Rhamnospermum bilobatum* Chandler
	**Wessexia fibrosa* (Chandler)
	Wessexia bournensis n. sp.
	Carpolithus spinossissimus n. sp.

2. BOURNEMOUTH MARINE BEDS

Family	Genus and species
Pteridophyta	
Filicales	
Polypodiaceae	***Acrostichum lanzaeanum* (Visiani)
Osmundaceae	***Osmunda lignitum* (Giebel)
Gymnospermae	
Coniferales	
Araucarineae	***Araucarites sternbergi* Goeppert
Taxodineae	***Sequoia couttsiae* Heer
Cupressinaceae	***Cupressistrobus gardneri* Chandler
	(*Cupressus taxiformis* Gardner)
Angiospermae	
Monocotyledones	
Potamogetonaceae	***Potamogeton pygmaeus* Chandler
	***Limnocarpus forbesi* (Heer) also in older beds in Selsey Peninsula and ?at Whitecliff Bay
Hydrocharitaceae	***Stratiotes hantonensis* Chandler
Cyperaceae	
Caricoideae	***Caricoidea obscura* Chandler
	***Caricoidea angulata* n. sp.
Palmae	
Lepidocaryinae	
Calameae	***Calamus daemonorops* (Unger)
Corypheae	***Sabal* sp.
	***?Nipa burtini* (Brongniart)
Nipaceae	
Dicotyledones	
Betulaceae	**Carpinus boveyanus* (Heer)
Caryophyllaceae	**Hantsia pulchra* (Chandler)
Nymphaeaceae	**Brasenia ovula* (Brongniart)
Menispermaceae	***Palaeococculus lakensis* Chandler
	**Wardenia marginata* n. sp.
Lauraceae	*Laurocarpum* spp.

Family	Genus and species
Hamamelidaceae	****Protoaltingia hantonensis*** Chandler
?Leguminosae	Genus?
Rhamnaceae	***Frangula hordwellensis*** Chandler
Theaceae	
Taonabeae	****Cleyera? stigmosa*** (Ludwig)
	****Hordwellia crassisperma*** (Chandler)
Thymelaeaceae	***Thymelaeaspermum bournense*** n. sp.
Lythraceae	****Palaeolythrum bournense*** Chandler
Cornaceae	
Mastixioideae	****Eomastixia rugosa*** (Zenker)
	****Mastixicarpum crassum*** Chandler
	Mastixia? glandulosa Chandler
Ericaceae	
Andromedeae	*Genus? sp. 2?
Epacridaceae	***Epacridicarpum headonense*** Chandler
Incertae Sedis	****Rhamnospermum bilobatum*** Chandler
	****Carpolithus arnensis*** Chandler

3. LIGNITES BELOW AND/OR ABOVE THE BOSCOMBE SANDS

Family	Genus and species
Gymnospermae	
Coniferales	
Taxodineae	****Sequoia couttsiae*** Heer
Cupressinaceae	****Cupressistrobus gardneri*** Chandler
Angiospermae	
Monocotyledones	
Potamogetonaceae	****Potamogeton pygmaeus*** Chandler
	****Limnocarpus forbesi*** (Heer)
Hydrocharitaceae	****Stratiotes hantonensis*** Chandler
Cyperaceae	
Caricoideae	****Caricoidea obscura*** Chandler
	****Caricoidea angulata*** n. sp.
	Caricoidea sp.
Palmae	****Sabal*** sp.
	Palmospermum sp.
Dicotyledones	
Betulaceae	****Carpinus boveyanus*** (Heer)
Caryophyllaceae	****Hantsia pulchra*** (Chandler)
Nymphaeaceae	****Brasenia ovula*** (Brongniart)
Menispermaceae	****Wardenia marginata*** n. sp.
Lauraceae	*Laurocarpum* sp.
Hamamelidaceae	****Protoaltingia hantonensis*** Chandler
Rutaceae	****Rutaspermum excavatum*** Chandler
	Rutaspermum rugosum n. sp.
	Toddaliospermum ornatum n. gen. & sp.
Icacinaceae	*Stizocarya* sp.

Family	Genus and species
Vitaceae	*Vitis* sp.
Theaceae	
Taonabeae	***Cleyera*? *stigmosa* (Ludwig)
	***Hordwellia crassisperma* (Chandler)
Thymelaeaceae	*Daphne bournensis* n. sp.
	**Thymelaeaspermum bournense* n. sp.
	?Thymelaeaspermum sp.
Cornaceae	
Mastixioideae	***Eomastixia rugosa* (Zenker)
	***Mastixicarpum crassum* Chandler
	***Mastixia*? *glandulosa* Chandler
Symplocaceae	***Symplocos headonensis* Chandler
	Symplocos sp.
Solanaceae	***Solanispermum reniforme* Chandler
Incertae Sedis	***Rhamnospermum bilobatum* Chandler
	**Carpolithus apocyniformis* Chandler

4. HIGHCLIFF SANDS, CLIFF END, MUDEFORD

Family	Genus and species
Pteridophyta	
Filicales	
Schizaeaceae	**Lygodium kaulfussi* Heer
Gymnospermae	
Coniferales	
Araucarineae	**Araucarites sternbergi* Goeppert
Pinaceae	*Pinus* sp.
Taxodineae	***Sequoia couttsiae* Heer
Cupressinaceae	**Cupressistrobus gardneri* Chandler
Angiospermae	
Monocotyledones	
Potamogetonaceae	***Potamogeton pygmaeus* Chandler
	***Limnocarpus forbesi* (Heer)
Hydrocharitaceae	***Stratiotes hantonensis* Chandler
Cyperaceae	
Caricoideae	***Caricoidea obscura* Chandler
	Scleriocarya tribrachteata n. gen. & sp.
	**Cladiocarya foveolata* Reid & Chandler
Palmae	
Lepidocaryinae	
Calameae	***Calamus daemonorops* (Unger)
Dicotyledones	
Betulaceae	***Carpinus boveyanus* (Heer)
Caryophyllaceae	***Hantsia pulchra* (Chandler)
Nymphaeaceae	***Brasenia ovula* (Bongniart)
Menispermaceae	*Palaeosinomenium* spp.
Rosaceae	***Rubus acutiformis* Chandler
Rutaceae	**Rutaspermum rugosum* n. sp.
	**Toddaliospermum ornatum* n. gen. & sp.
	Toddaliospermum excavatum n. sp.

Family	Genus and species
Vitaceae	*Vitis* sp.
Tiliaceae	*Grewia minima* n. sp.
Dilleniaceae	***Actinidia eocenica* n. sp.
Theaceae	
Theeae	*?*Gordonia truncata* Chandler
Taonabeae	*Eurya mudensis* n. sp.
	***Cleyera? stigmosa* (Ludwig)
	**Cleyera? lentiformis* n. sp.
	?Cleyera sp.
	Genera?
	***Hordwellia crassisperma* (Chandler)
Flacourtiaceae	**Oncoba rugosa* Chandler
Thymelaeaceae	**Thymelaeaspermum bournense* n. sp.
Lythraceae	**Microdiptera parva* Chandler
	***Palaeolythrum bournense* Chandler
Nyssaceae	**Nyssoidea eocenica* Chandler
Cornaceae	
Mastixioideae	***Eomastixia rugosa* (Zenker)
	***Mastixicarpum crassum* Chandler
	***Mastixia? glandulosa* Chandler
Cornoideae	***Dunstania glandulosa* Chandler
Clethraceae	*Clethra hantonensis* n. sp.
Epacridaceae	***Epacridicarpum headonense* Chandler
	**Epacridicarpum mudense* Chandler
	Genus?
	?Leucopogon sp.
Symplocaceae? (or Cornaceae?)	Genus?
Boraginaceae	
?Ehretioideae	Genus?
Solanaceae	***Solanispermum reniforme* Chandler
Caprifoliaceae	*Sambucus mudensis* n. sp.
Cucurbitaceae	*Cucurbitospermum mudense* n. sp.
Incertae Sedis	***Rhamnospermum bilobatum* Chandler
	***Wessexia fibrosa* (Chandler)
	Carpolithus echinatus n. sp.
	Carpolithus ornatus n. sp.
	Carpolithus mudense n. sp.
	**Dicotylophyllum pinnatifidum* Reid & Chandler

D. Analysis of Plant Lists

1. BOURNEMOUTH FRESHWATER BEDS

The Bournemouth flora was alleged by Gardner & Ettingshausen (1879: 3) to show strong American affinities, 'Australian Proteaceae being replaced by American Myricas'. But the American relationship was probably exaggerated through ignorance in those early days of the living floras of the Far East and of the rich seed and fruit remains in the deposit with tropical Asiatic affinities, also through mistaken determinations. That there were affinities with America

cannot be overlooked. Thus *Sequoia* survives only in America today although in the Eocene it was widely distributed, so also does *Taxodium* if indeed this genus really occurs at Bournemouth. *Anemia* has its present-day centre of distribution in the New World although its Eocene range was wide and it remains as a relic in Angola, Nigeria, East Africa, South-west India, Madagascar and Natal. In the New World it ranges north as far as the Sierra Nevada in the west and Florida in the east. Other connexions with America are also afforded by genera which occur today in both hemispheres e.g. *Lygodium*, *Dicranopteris* and *Magnolia*. *Meliosma* is also native of tropical and subtropical Asia and America and although commonly a mountain shrub or small tree, also has lowland species in Singapore (information from Dr. Holttum). *Potamogeton pygmaeus*, thought at one time by Chandler to be related to a Japanese species, has its Recent analogue in *P. spirillus* Tuckerm., a North American form (based on information from Professor Dorofeev: letter of 9.5.59), *P. pygmaeus* however is very rare at this horizon. *Oncoba* and *Cleyera* also occur in both hemispheres.

An even greater number of plants have marked south-eastern Asiatic affinities: *Calamus*, *Protoaltingia*, *Phellodendron*, *Natsiatum*, *Actinidia*, the Mastixioideae; *Osmunda* also if Gardner was right in his opinion of the relationship of *O. lignitum* to *O. javanicum*.

The abundance of ferns points to warm humid conditions and the presence of *Acrostichum*, *Lygodium* and *Anemia* to a tropical or at least a subtropical climate. The same indication is given by *Calamus*, the large palm leaves found by Gardner, *Ficus*, Menispermaceae, Anonaceae, Lauraceae, Capparidaceae, probably Burseraceae, *Oncoba* and certainly by Spondieae and Mastixioideae.

The fact must not be overlooked that a family which today is essentially temperate, for example the Hamamelidaceae or Thymelaeaceae, both abundant in the later beds at Southbourne, may still have extensions into the tropics perhaps through the exceptional distribution of only one or of a few genera. In like manner an almost wholly tropical family like the Euphorbiaceae can have limited extensions into temperate regions. It is not impossible therefore that in the Eocene some families, today restricted more or less to temperate latitudes, may formerly have extended into warmer wetter regions although such a connexion no longer exists in the living family through the extinction of ancient representatives. To what extent the more 'temperate type' fossils belong to this category or alternatively to what extent they were truly upland species can only be demonstrated by prolonged future research. That upland species were present, swept down from higher ground by rivers in spate, is fairly certain. This is suggested by the massed occurrence of coniferous branches described by Gardner. Perhaps the sparsely represented genera *Alnus*, *Morus*, *Rubus* and *Phellodendron* belonged to this category. It should be noted that, as in the Dorset Pipe-clay Series, few genera have been found which are wholly temperate at the present time, apart from wide ranging marsh or water plants.

In the Bournemouth Freshwater flora aquatic and subaquatic plants constitute a fairly conspicuous element, a fact which is not surprising in vegetation closely associated with river deposits. Examples of such plants are *Potomogeton*, *Stratiotes* (the earliest geological record), Cyperaceae, Nymphaeaceae, *Alnus* and the Lythraceae.

Evidence is accumulating which may indicate that there was once a belt of more or less uniform vegetation around the equatorial regions of the world in the Eocene and that different parts of this belt may in some instances have had identical species, others related species.

Subsequent world history appears to have segregated or differentiated species in separated parts of the equatorial belt.

Comparison with Older Floras

Of the seventy-two species listed from the Bournemouth Freshwater Beds, those marked with two or more asterisks, about thirty in all, i.e. more than a third of the total, are common to these Beds and to the Pipe-clay Series, some being found at even older horizons. Having regard to the small amount of material examined and to differences of sedimentation, this indicates that the floras are of essentially the same type: the climate and phytogeographical connexions signified by the one set of plants are also signified by the other.

If the Lower Bagshot (Pipe-clay Series) appears to be richer in tropical species than the Bournemouth Freshwater Beds this may well be due to the better, more accessible exposures with their rich seams of vegetation at the older horizon rather than to any intrinsic difference between the two floras which have so much in common.

The plants of the Bournemouth Freshwater Beds are Poltavian in type as described in the Palaeocene, the London Clay and the Dorset Pipe-clay Series (Chandler, 1961: 196). That different plants are to some extent represented is natural in view of the hazards of preservation and the large elements of chance which govern the discovery of fossilized plant remains.

Although in the London Clay preservation is so utterly different it is interesting to note that identical species have now been found e.g. *Anemia poolensis*, *Cleyera*? *stigmosa* (published as *Myrtospermum variabile*), *Palaeococculus lakensis*, and *Vitis pygmaea* in the London Clay of Nursling. This is almost the only exposure in the London Clay where the preservation of the fruits is comparable with that of the carbonaceous elements in the Bournemouth cliff sections. *Sequoia couttsiae* and *Natsiatum eocenicum* are new and as yet unpublished records for the London Clay. The species of *Meliosma* and *Magnolia* at Bournemouth may well be identical with some from the London Clay as suggested in the systematic section. *Spondiaecarpon operculatum* is definitely an identical species. Some of the Bournemouth plants even predate the London Clay. Such are *Anemia subcretacea*, *Sequoia couttsiae*, *Cupressistrobus gardneri*, *Phellodendron costatum* and *Cleyera*? *stigmosa* in the Woolwich or Reading Beds. *Becktonia*, *Palaeosinomenium*, *Anonaspermum*, *Laurocarpum*, *Protoaltingia*, *Euphorbiotheca*, *Dunstania* and *Symplocos* are London Clay genera.

The number of ferns in the Bournemouth Beds is noticeable and is in striking contrast to their rarity in the London Clay. This is due in part at least to the fact that whereas ferns would be an important element in a river-side flora growing on forest-clad banks they would only be preserved in abundance where their delicate fronds could form impressions in a fine matrix. They would scarcely survive in far transported débris, nor would they be expected in the coarse sediments from which most of the Lower Bagshot species have been retrieved. In this last mentioned deposit only the tightly enrolled minute fertile pinnules of *Anemia poolensis* are at all common.

An interesting find is the earliest *Stratiotes* at Sandbanks. This minute form might easily have escaped recognition if it had not been for a previous considerable acquaintance with many species of *Stratiotes*.

A number of plants listed from Bournemouth e.g. Moraceae Genus?, Nymphaeaceae Genus? two species, Leguminosae Genus?, *Euphorbiotheca* sp., *Vitis* sp., ?*Tilia* sp.,

?*Abelia* sp. are tantamount to a confession of failure to determine their nearer affinities. Some of these are based on such limited material that a closer determination would be most unwise. Could it have been made it is quite possible that they would have corresponded in some cases at least, with species from older or younger deposits. They might then have afforded additional evidence showing the essential unity of these older Tertiary floras.

2. BOURNEMOUTH MARINE BEDS

Passing on to consider the overlying and in part equivalent Bournemouth Marine Beds which mark the seaward end of the Eocene estuary it is at once apparent that the same flora is present at this horizon also, albeit more poorly represented. These strata have not so far yielded the rich productive seams and pockets found in the Freshwater Beds. In rare instances where plant pockets have been mentioned the fruits from them have either never been collected or have now largely disappeared. Conditions at the mouth of the estuary would in any case be less favourable for the preservation of delicate remains and Gardner who had far better opportunities for collecting than those which are ours does not speak of the wealth of plants in these beds that he reports in the Freshwater Series. In actual fact he mentions only *Acrostichum*, *Araucarites*, *Cupressus taxiformis* (= *Cupressistrobus gardneri*) and *Nipa* while Ord (1914) refers to small *Sabal*-like leaves. The unfavourable environment for fossilization is reflected in the plant list which is less than half the size of that from the Freshwater Beds, namely thirty-three species as against seventy-two. Nevertheless about half of the plants are actually known from the Bournemouth Freshwater Beds. In the case of *Limnocarpus*, *Nipa* and *Palaeococculus* there are even older records viz. *Limnocarpus* doubtfully from the Cuisian of the Isle of Wight and definitely from the Lutetian–Auversian boundary in the Selsey peninsula; *Nipa* from the London Clay and from Cuisian and Lutetian Beds in the latter locality; *Palaeococculus* from the London Clay and the Dorset Pipe-clay Series. None of these three has yet been found in the Bournemouth Freshwater Series. Almost all the Marine Bed plants are found in younger beds: *Acrostichum lanzaeanum* ranging up into the Oligocene (Bembridge); *Sequoia couttsiae*, *Limnocarpus forbesi*, *Sabal* sp., *Brasenia ovula*, *Rhamnospermum bilobatum* to the Hamstead Beds; while *Calamus*, *Carpinus* and *Brasenia* are found at Bovey. A number of other species: *Caricoidea obscura*, ?*Nipa burtini*, *Hantsia pulchra*, *Protoaltingia hantonensis*, *Hordwellia crassisperma*, *Cleyera*? *stigmosa*, *Palaeolythrum bournense* and *Epacridicarpum headonense* have been traced so far up to the Lower Headon and in the case of *Hordwellia* and *Epacridicarpum headonense* to the Upper Headon of Colwell. *Rhamnospermum bilobatum*, whatever it may be, is ubiquitous throughout Eocene and Oligocene strata both in freshwater and estuarine beds. The most abundant plants in the Bournemouth Marine Beds are those like *Sequoia couttsiae* and the Mastixioideae which range widely in time up and down the Eocene scale and are common at all horizons. The following are worthy of individual comment: *Acrostichum lanzaeanum* appears at intervals in the Eocene and Oligocene where the influence of the sea is not far away. In European deposits outside England it is reported again and again. *Potamogeton pygmaeus* is barely represented in the Bournemouth Freshwater Beds and the same is true of *Stratiotes hantonensis*. *Limnocarpus forbesi* does not occur until the Bournemouth Marine Beds but all are so abundant at this horizon and later as to suggest a gregarious habit. A question which cannot at present be settled is, did they appear in force at this period

and in later beds because they were only able to flourish in brackish water? *Nipa* is a plant which would not occur in purely continental deposits but it is not surprising that it reappears in beds formed on the seaward side of the coast line. It is highly probable that pinnate palm leaves from Hordle belong to *Nipa* and in any case its fruits are found in Belgium as late as the Bartonian (Wemmelian) (Seward & Arber, 1903: 4). *Calamus* jungle seems to have been a feature of Eocene and Oligocene vegetation if Bovey is of this latter age. The genus is associated with *Carpinus* both at Bovey and in the Bournemouth Marine Beds. *Brasenia ovula* appears from now onwards to have taken the place of *Palaeonymphaea*, possibly it is again a brackish water plant while *Palaeonymphaea* is strictly freshwater but it may of course be a later developed form, *Palaeonymphaea* being an older representative of the family.

3. LIGNITES BELOW AND ABOVE THE BOSCOMBE SANDS

Hitherto there have been no plant records from these beds and even now only a few species are known. The beds yield abundant specimens of certain common species which must have formed floating sodden rafts of vegetation like those described. A large proportion of the species recorded occur both in younger and older beds so that the list of plants is very similar to that of the Marine Beds below and also similar to but smaller than that of the Highcliff Sands above. There appear to be no records of importance peculiar to this horizon but no doubt the rafts are not fully representative of the flora of this phase. Of the thirty-four plants listed ten are also found in the Dorset Pipe-clay list.

4. HIGHCLIFF SANDS, CLIFF END, MUDEFORD

In spite of the sparseness of the seams and the minute scraps or fragments of plants of which they are formed the plant list at this horizon is richer than in the two preceding cases but not as large as that of the Bournemouth Freshwater Beds. It would therefore appear that these tiny fragments swept out to sea by eddies came from a larger and more varied gathering ground than those preserved in the Boscombe Sands or Bournemouth Marine Beds. Consequently the plant list is varied by the addition of a few species not found earlier e.g. *Scleriocarya tribracteata*, *Cladiocarya foveolata*, *Palaeosinomenium* spp., *Toddaliospermum excavatum*, *Grewia minima*, *Microdiptera parva*, *Eurya mudensis*, *Clethra hantonensis*, *Epacridicarpum mudense*, *Sambucus mudensis* and *Cucurbitospermum mudense* as well as three named species of *Carpolithus*. There are also thirty species, nearly two-thirds of the whole, which link the Highcliff Sands flora with that of the older beds and twenty-five which are found in the Eocene Bartonian and Lower Headon, or at Bovey and other Oligocene deposits. *Stratiotes hantonensis* is near the end of its career. It disappears at the base of the Lower Headon. *Palaeosinomenium*, *Oncoba rugosa*, *Thymelaeaspermum bournense* and *Nyssoidea eocenica* have not yet been traced into the Bartonian, either in the Barton Beds themselves or in the freshwater and estuarine Lower Headon. By this time *Microdiptera parva* has taken the place of the more impressive *M. major* of the Bournemouth Freshwater Beds. In spite therefore of these slight indications of a changing plant population the Poltavian flora still appears to be dominant. Some of the large fruits of the Dorset Pipe-clay Series are no longer found. Their apparent absence may be due to accident or to the fact that there are no continental beds in which they could have accumulated. Or of course it may be due to a development of the flora with the passage of

time. In the Lower Headon flora of Hordle, in part of continental type, some of the Poltavian elements are apparent (Chandler, 1961*b*).

This slowly evolving flora indicative of a warm moist climate appears to have persisted from the Palaeocene at least to the Early or Middle Oligocene though it is naturally preserved in greatest richness and variety in the freshwater beds. The one exception to this statement is afforded by the London Clay where the peculiar preservation enabled the plants to be fossilized and collected in abundance and rich variety under marine conditions. It cannot be too strongly emphasized, however, that great caution is needed in drawing inferences from the *absence* of genera or species. It may be accounted for by accident of transport and preservation or by purely local conditions and is undoubtedly due in part to the chances which make rich exposures available at one locality or horizon and not at another. While therefore the general aspect of the Dorset Pipe-clay Series appears at first sight to be more tropical than that of the Bournemouth deposits much may be attributed to the good Dorset exposures, readily accessible for long periods and rich in carbonaceous seams deposited by repeated floods.

5. BRACKLESHAM OF ALUM BAY, ISLE OF WIGHT

In Alum Bay freshwater beds of supposed Bracklesham age lie between the Lower Bagshot and the Barton Beds. They may be regarded as representing the more easterly development of the continental phase of the Hampshire Middle Bagshot Beds and the Bracklesham deposits. On this assumption presumably they are the equivalent of the marine Bracklesham phase further east in Whitecliff Bay and at Selsey. In an address to the British Association Etheridge (1883) stated that the 'Middle Bagshots [his Bournemouth Freshwater and Marine Beds] are represented in Alum Bay by unfossiliferous beds marked 19 to 24 in Prestwich's section (1854: 56) and are 240 feet thick'.

In 1932, a small sample was taken from one of the dark approximately vertical carbonaceous bands of this series. After boiling and sifting, it yielded a few poorly preserved shreds and fragments of vegetation and among them a single seed of *Cleyera? stigmosa*, two specimens of *Scirpus lakensis* and a few poorly preserved indeterminable seeds. Although the yield was so poor it is possible that persistent search might add to this small number of plants and more especially that a search for spores and pollen might yield valuable results, but the distortion and movement the beds have undergone and their almost vertical position do not afford the most favourable conditions for the collection of a rich, well-preserved flora of fruits and seeds.

To summarize: up to the present plants have not provided an answer to the problem of the exact age of successive beds in the continuous western sections of the Hampshire Basin, nor do they indicate where the boundaries between successive stages lay. The few plants obtained from the well dated but botanically poor deposits of the corresponding area at Selsey have been described by Chandler, 1961*a*.

SYSTEMATIC DESCRIPTIONS

Pteridophyta

Order *FILICALES*

Family POLYPODIACEAE

Genus GONIOPTERIS Presl

Goniopteris bunburii (Heer)

1862 *Lastraea bunburii* Heer, p. 28, pl. 12, fig. 1*b*.
1879 *Phegopteris bunburii* (Heer): Gardner & Ettingshausen, p. 38, pl. 5.
?1879 *Phegopteris prae-cuspidata* Gardner & Ettingshausen, p. 37, pl. 4, figs. 8, 9.
1880 *Goniopteris bunburii* (Heer) Gardner & Ettingshausen, pl. 10, fig. 9, 9*a*.
1882 *Goniopteris bunburii* (Heer): Gardner & Ettingshausen, p. 63.

This species was found in the Freshwater Beds under the Coastguard station and was associated with dicotyledonous leaves. Heer and Gardner both believed it to be identical with material from Bovey Tracey by then no longer in existence. Gardner at first used the generic name *Phegopteris* and later *Goniopteris* and in his final revision (1882: 63) he compared it with two Brasilian species of *Goniopteris* and with *Nephrodium* especially *N. amboinense*. An ill-preserved incomplete fertile pinnule named *Phegopteris praecuspidata* Gardner & Ettingshausen (V.14948 with counterpart) was believed by Heer to belong to *G. bunburii* (Gardner & Ettingshausen, 1879: 37) and is included doubtfully in the list of synonyms given above. However, Gardner regarded it as distinct at first and in his final revision he united it with *G. stiriaca* (Unger) (1882: 71, 76). The figured material is V.14948–50 and in addition there are the following unfigured pinnules: V.15017, V.15016, V.15018–19, the last three being represented by counterparts.

Genus PTERIS Linnaeus

Pteris eocenica Gardner & Ettingshausen

1879 *Pteris eocenica* Gardner & Ettingshausen, p. 32, pl. 4, figs. 4–6.
1882 *Pteris eocenica* Gardner & Ettingshausen: Gardner, p. 62, pl. 12, fig. 11, 11*a*.

Rare in Freshwater Beds to the west but common in the more easterly younger 'fern-beds' of the Freshwater strata. The species has only once been found west of the pier near the

flagstaff. Its occurrence indicates a preference for swamps and marshes near sea level. The fossil is compared by Gardner with the Recent *P. cretica*, a species of the subtropics and south temperate regions of both east and western hemispheres.

The original of Gardner 1882, pl. 12, fig. 11, 11*a* is stated by him to be preserved in the Geological Survey Museum. V.14944–46 are figured Gardner 1879, pl. 4, figs. 4–6. V.15015 is an unfigured fragment.

Genus ACROSTICHUM Linnaeus

Acrostichum lanzaeanum (Visiani)

1879 *Chrysodium lanzaeanum* (Vis.): Gardner & Ettingshausen, p. 26, pl. 1; pl. 2, figs. 1, 1*a*, 2, 2*a*.
1962 *Acrostichum lanzaeanum* (Vis.): Chandler, pp. 19, 39, pl. 5, figs. 4, 5. See also for earlier references.

This fern occurred both in the Freshwater and Marine Beds at Bournemouth being found especially on both sides of the Pier in the first-named deposits, but also to some extent throughout the section. Most of the specimens were detached and broken pinnules but V.14923 (figured Gardner, 1879, pl. 1 but now in poor condition) showed part of a stipe with a few attached pinnules while V.6456 is better preserved but with only two attached pinnules. It had a film of carbonaceous substance. The original of Gardner 1879, pl. 2, fig. 1, 1*a* has not been traced while V.14925 was figured Gardner 1879, pl. 2, fig. 2, 2*a*. Fragments on a matrix bearing *Podoloma polypodioides* (see p. 3) are V.14931, V.14992 and V.15000, the first mentioned preserved in pinkish white clay, the last in pinkish grey matrix which also bears a half buried berry of ?Lauraceae. It seems possible that the light-coloured pinkish specimens came from Studland as the well-authenticated Bournemouth *Acrostichum* pinnules are in a grey clay whereas specimens definitely known to be from Studland (V.14926–27, V.14989–90) are in light-coloured or pinkish matrix which may be a pipe-clay. There is a strong presumption that a few other Gardner specimens (V.14980–88) in similar matrix labelled 'Bournemouth, Dorsetshire' are also from Studland. It seems likely that Gardner at some period used the term 'Bournemouth' to cover the whole neighbourhood rather than the Bournemouth cliffs in the strict sense. The addition of the word 'Dorsetshire' points to the western end of the Eocene basin rather than to Bournemouth itself which is in Hampshire so that some at least of these Dorset specimens may be from Studland. On one such (V.14989) the late W. N. Edwards had actually written Studland, thereby indicating that he must have been in general agreement with this opinion or had definite grounds for the alteration. The Sedgwick Museum, Cambridge possesses a large pinnule in pinkish grey matrix (Gardner Collection) and a specimen (J. F. Walker Coll. 1908) of doubtful origin in a dark grey matrix labelled ?Barton (or ?Bournemouth). Other material V.46131-34.

The species has been described from the Lower Bagshot of Arne (Chandler, 1962: 39, pl. 5, figs. 4, 5).

Genus ADIANTUM Linnaeus

Section *Hewardia* J. Smith

Hewardia? regia Gardner & Ettingshausen

1879 *Hewardia regia* Gardner & Ettingshausen, pl. 2, fig. 5.
1880 *Hewardia regia* Gardner & Ettingshausen, p. 42, pl. 7, fig. 2; pl. 10, fig. 6, 6*a*; pl. 11.
1882 *Hewardia regia* Gardner & Ettingshausen: Gardner, p. 62.

A species found close to but west of Bournemouth Pier in the Freshwater Beds. It is described as an extinct type with anastomosing nervation and the suggested alliance with *Hewardia* should perhaps be regarded as doubtful. V.14967 figured Gardner & Ettingshausen, 1880, pl. 11, appears to represent the impression of the lower side of a leaf and shows a marginal indusium forming long linear patches which do not extend to the extremities of the lobes. The sporangia if present must have remained on the counterpart half for there is no trace of them on this impression. The indusium is striate at right angles to the margin of the leaf. The form and nervation are described fully by Gardner & Ettingshausen. They regarded the specimen (Gardner & Ettingshausen, 1879, pl. 2, fig. 5) as probably a small barren frond of the same species but as only the outline was preserved this is quite doubtful. The originals of Gardner & Ettingshausen, 1880, pl. 7, fig. 2; pl. 10, fig. 6, 6*a* and pl. 11, figs. 2, 3, parts of smaller pinnae, are missing.

Adiantum apalophyllum Saporta

1868 *Adiantum apalophyllum* Saporta, p. 313, pl. 2, fig. 1.
1880 *Adiantum apalophyllum* Saporta: Gardner & Ettingshausen, p. 42, pl. 10, fig. 1, 1*a*.
1882 *Adiantum apalophyllum* Saporta: Gardner, p. 61, pl. 12, fig. 7.

Detached adiantoid pinnae, some showing in part the arrangement of linear sori (as opposed to obversely reniform), were found in the *Gleichenia* beds and at other horizons associated with dicotyledonous leaves in the Freshwater Beds west of Bournemouth Pier. Saporta appears to have agreed to the association of these remains with his species (Gardner & Ettingshausen, 1880: 42). V.14974–75 are Gardner's figured specimens. V.15028–29 are rounded pinnules with marginal sori.

Adiantum sp. (?)

1886 *Adiantum* sp. Gardner, pp. 401, 404, pl. 3, fig. 10, 10*a*.

Five pinnules in the position of growth but without the rachis. The margin is finely denticulate, the fronds are very fine and delicate, the impression being colourless. Most of the veins diverge from the base, 'repeatedly forking' so that their relative distances are maintained to the margin. They are more crowded than in *A. apalophyllum*. To Gardner the pinnules appeared identical with those of *A. flabellulatum* Linn., of Ceylon, Japan, Hindustan and the Malay Peninsula and Islands, but the remains were rather scanty for satisfactory determination.

Family GLEICHENIACEAE

Genus DICRANOPTERIS Holttum

Dicranopteris hantonensis (Wanklyn)

Plate 7, figs. 8, 9; Text-fig. 5

1869 *Mertensites hantonensis* Wanklyn, p. 11, pl. 1, fig. 1 (?2).
1869 *Mertensites crenata* Wanklyn, p. 12, pl. 1, fig. 3.
1880 *Gleichenia hantonensis* (Wanklyn): Gardner & Ettingshausen, p. 43, pl. 6; pl. 10, figs. 2–4.
1882 *Gleichenia hantonensis* (Wanklyn): Gardner, p. 59, text-fig. 28.
1957 *Dicranopteris hantonensis* (Wanklyn) Holttum, p. 168.

This peculiar species occurred in a thin band of the Freshwater Beds under the Highcliff Mansions (i.e. a short distance west of the pier), Bournemouth, associated with dicotyledonous leaves and massed together above a marly bed penetrated by its roots 'which seems to imply that it flourished in a considerable patch in a wet clayey hollow' (Gardner & Ettingshausen, 1880: 45).

The specimens figured by Gardner (1880, pl. 10, figs. 2–4) and Wanklyn (1869, pl. 1, fig. 1*b*, 1*c*) are in the Sedgwick Museum, Cambridge. Other specimens are in the British

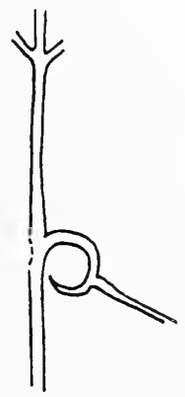


Fig. 5. *Dicranopteris hantonensis* (Wanklyn). Diagram based on V.15022 showing stipe produced beyond paired hooks which bear branches. Left hook of pair has been chiselled away in developing specimen. Distally the stipe gives rise to another pair of branches of which only proximal ends are preserved.

Museum (Natural History) viz. V.14951–55 (figured respectively by Gardner & Ettingshausen, 1880, pl. 6, figs. 7–11) and V.15020–24, four of which show pinnae.

Gardner described the stipe and rachis as slender, always associated with and sometimes attached to remains of pinnules. The stems are repeatedly forked dichotomously with young buds at the forking of the larger stipes (cf. V.14952 an unfigured fragment on a slab bearing the original of Gardner & Ettingshausen, 1880, pl. 10, fig. 8. Also V.14955). A peculiar feature, unlike anything in living Gleicheniaceae, is a hook at the base of single pinnae representing in Gardner's opinion an aborted second pinna. His view finds support from Wanklyn's specimen figured 1869, pl. 1, fig. 1*b* in which a close scrutiny of the fossil itself shows that there are clear remains of reduced pinnules with nerves clothing the hooks as shown in the figure. Midribs of the pinnae are slender and slightly sinuous, the pinnae being elongate, almost lanceolate and bearing linear or lanceolate close-set pinnules of unequal length with crenate or entire margins and rounded apices. Midribs of the pinnules are also sinuous and slender leaving the rachis normally at angles of 65° to 85°; secondary nerves leave the midrib at the same angles. The first secondary nerve in each pinnule is given off on the basal side of the midrib (catadromous) the nerves being mostly forked, rarely simple. Ternary nerves are also catadromous and usually simple. Sori are observed on one or both of the exterior nervules

of each group. The sporangia were described by Gardner as deciduous, six or eight in each sorus arranged around a small punctiform receptacle. His fertile specimens show that the sporangia are preserved, now at least, as hollow impressions in the matrix, the diameter of sori being about 0·8 to 0·9 mm. and of the circular receptacle impression about 0·2 mm. The transverse diameter of the sporangia is about 0·3 mm., occasionally even larger. Dr. Holttum noted at least ten sporangia. A few of the hollow impressions may perhaps be due to dehiscence of certain sporangia into two longitudinal halves. Obscure evidence suggests that the sporangium walls are of straight-sided cells about 0·05 by 0·025 mm. in diameter. A few impressions suggest annuli broadest towards the circumference of the sorus, narrowed towards the receptacle, almost encircling the sporangium and formed of straight, thick-walled cells about 0·05 to 0·075 mm. deep and 0·05 mm. wide. Apart from figured specimens a small pinnule fragment with good sori impressions is still preserved in the Sedgwick Museum and another (V.15024) in the British Museum (Natural History). A reconstruction based on various separated fragments was given by Gardner (1882, text-fig. 28).

Dr. Holttum recently examined the material in view of work he was carrying out upon comparative morphology and branching habits of primitive fern families. He stated (1957: 181) that the branching and the detached pairs of leafy ultimate branches with a dormant apex between them agreed with Gleicheniaceae. He referred the Bournemouth fossils to the genus *Dicranopteris* as defined by himself (1957). This relationship is supported by nervation and the position and number of sori. Holttum agreed with Gardner that the leaflets with similar nervation and lamina to the above but bearing the curved hooks described were unlike anything known among living ferns but doubted the correctness of Gardner's reconstruction in his text-fig. 28 in that it incorporated two pinnule types not combined in any living plant and not, he believed, justified by the evidence available. Nor could he see grounds for adding in the reconstruction accessory branches deflexed from the outside of a fork such as are found today in *Gleichenia linearis* (personal communication, 16.5.57). He commented that the hook-bearing branches existed only as isolated pairs except for one figured specimen (V.14953, Gardner & Ettingshausen, 1880, pl. 6, fig. 9) and was not convinced that the prolongation of the axis beyond the hooks as drawn in the figure of this fragment really existed because the supposed prolongation lay at a slightly different level in the rock from the rest of the specimen. A further close scrutiny of the specimen does however appear to the writer to confirm Gardner's interpretation for the difference of level is due to the greater thickness of the axis at the point where the hook-bearing branches are given off and the impression of the axis can certainly be traced continuously across it into its prolongation. Dr. K. I. M. Chesters kindly examined the specimen and confirms this observation.

Some supporting evidence that the axis may be prolonged beyond the hooks is also afforded by an unfigured fragment, V.15022 (Text-fig. 5). It shows a similar branched stipe with axis continued beyond the hook-bearing branches and giving rise distally to another pair of branches of which only the proximal ends are preserved. Beyond this second pair of branches it appears to have been continued also. Unfortunately one of what was clearly a pair of hooks has been chiselled away in developing the specimen but the prolongation of the axis is unmistakable. Gardner suggested that the conversion of normal pinnae into tendril-like supports might have been compensated by the development in this fossil species of buds present but rudimentary between the forks of the stem in living forms.

As to the accessory branches deflexed from the outside of a fork, his account (1882: 60) makes it clear that their introduction into the restoration was purely an hypothesis based on an analogy with *Gleichenia dichotoma* but not on unmistakable evidence. It is hoped that further material from old collections may yet be found which will serve to demonstrate the structure of this interesting species and clear up doubtful points.

The genus *Dicranopteris* consists of *D. linearis* (*Gleichenia dichotoma*) and its allies distributed throughout the tropics, these being the dominant members of the family in equatorial lowlands, and *D. pectinata* of tropical America.

Family OSMUNDACEAE

Genus OSMUNDA Linnaeus

Osmunda lignitum (Giebel)

1857 *Pecopteris lignitum* Giebel, p. 305, pl. 2, fig. 2.
1857 *Pecopteris leucopetrae* Giebel, p. 304, pl. 2, fig. 1.
1857 *Pecopteris angusta* Giebel, p. 306, pl. 2, fig. 3.
1857 *Pecopteris crassinervis* Giebel, p. 307, pl. 2, fig. 4.
1879 *Osmunda lignitum* (Giebel): Gardner & Ettingshausen, pl. 4, figs. 1–3.
1880 *Osmunda lignitum* (Giebel): Gardner & Ettingshausen, p. 49.
1882 *Osmunda lignitum* (Giebel): Gardner, p. 66.

The species was found in the Freshwater Beds on both sides of Bournemouth Pier; there were fragments also in the 'Fern Beds' immediately underlying the Marine Series while a single fragment was obtained from the Poole end of the section (Gardner & Ettingshausen, 1880: 50). The Bournemouth material they regarded as identical with fronds from Bovey Tracey described by Heer as *Osmunda lignitum* (1862: 1047, pl. 55, figs. 5, 6; pl. 56, figs. 2–11) making only a few minor corrections in his description. They regarded the species as indistinguishable from '*O. javanicum* Blume', a name now known to have been applied to a number of Recent species ranging from the Philippines and Ceylon to China, Japan and Kamschatka. Dr. Holttum kindly supplied the information that Gardner & Ettingshausen's figured material is very close to the species *O. banksiifolia* (Presl) Kuhn of China and Japan which although included in *O. javanicum* in Synopsis Filicum (Hk. & Bak.) is apparently quite distinct from the *O. javanicum* of the Malay Peninsula. *O. zeylanica* Kze is, he stated, an allied form but the living genus is at present undergoing revision. Gardner (1882: 69) knowing nothing of these complications commented that the largest living fronds and plants of *O. javanicum* were today found in the most southerly part of its range of distribution but that pinnae from Formosa (lat. 24°) most nearly agreed with the fossil.

The discovery of sporangia with spores at Bovey which may reasonably be supposed to belong to the leaves so commonly represented there was reported by Chandler (1957: 80). The spores are similar in size and ornamentation to those of *O. regalis* (45 to 68·5μ) some of which have rather coarser tubercles.

Gardner's figured specimens from Bournemouth are V.14937–43. There are, too, unfigured pinnule or pinnule fragments, V.15011–14 and a single specimen in the Sedgwick Museum, Cambridge.

Family SCHIZAEACEAE

Sub-family LYGODIEAE

Genus LYGODIUM Swartz

Lygodium kaulfussi Heer

Text-fig. 6

1880 *Lygodium Kaulfussi* Heer: Gardner & Ettingshausen, p. 47, pl. 7, figs. 1, 3–8; pl. 10, fig. 11.
1882 *Lygodium Kaulfussi* Heer: Gardner & Ettingshausen, pl. 13, figs. 8, 9.
1955 *Lygodium kaulfussi* Heer: Chandler, p. 308, pl. 37, fig. 78; pl. 38, figs. 86, 87.
1962 *Lygodium kaulfussi* Heer: Chandler, p. 20.

The species was fully described by Chandler (1955) but a few additional facts about the sporangia have since been discovered in a fertile pinnule from the Freshwater Beds, Branksome Dene. A sporangium from this specimen is 0·557 mm. long, 0·275 mm. broad. The annulus is

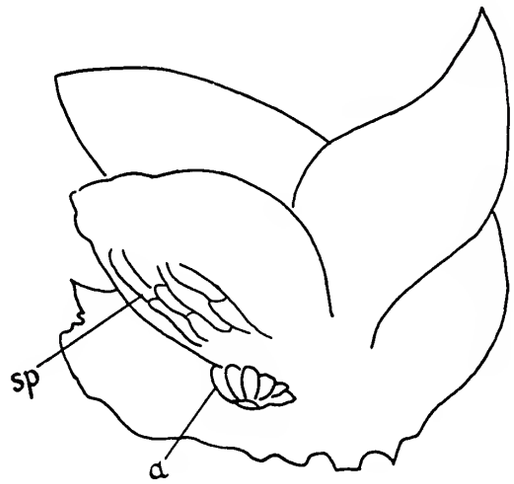


Fig. 6. *Lygodium kaulfussi* Heer. Diagram of fragment of fertile pinnule showing sporangium, *sp*, with annulus, *a*.

near the inner end of the sporangium on its lower side and is 0·11 mm. in diameter. Cells of the sporangial wall are elongate, more or less rectangular and not digitate. Cells of annulus thick-walled and elongate. The fern was found by Gardner sparingly in the Freshwater Beds associated with dicotyledonous leaves and more rarely with remains of other ferns. It was seen occasionally in leaf beds under the Highcliff Hotel but was commoner at the western end of the Bournemouth cliffs near Poole Harbour. Fertile pinnules not associated with the barren ones were found under Highcliff Mansions. Others have recently been discovered and described from Branksome Dene (Chandler, 1955 and V.43688). A collapsed spore was found in the Highcliff Sands near Mudeford (Chandler, 1955, pl. 38, fig. 87), where there were apparent fragments of pinnule. Gardner's (1880) figured material is V.14956–64. V.14957 is represented

by counterparts and V.14962 is a fertile pinnule. Other unfigured pinnules are V.375 and V.15025–27. Remains were abundant in the Dorset Pipe-clay Series, Studland (Chandler, 1955: 308, pl. 37, figs. 70–77, 79–83; pl. 38, figs. 84, 85).

Sub-family ANEMIEAE

Genus ANEMIA Swartz

Anemia subcretacea (Saporta)

Plate 7, figs. 1–7; Text-fig. 7

1868 *Asplenium subcretaceum* Saporta, p. 315, pl. 23, fig. 4.
1880 *Anemia subcretacea* (Saporta): Gardner & Ettingshausen, p. 45, pl. 8; pl. 9.
1882 *Anemia subcretacea* (Saporta): Gardner & Ettingshausen, p. 67.
1886 *Anemia subcretacea* (Saporta): Gardner, pp. 400, 402, pl. 1.
1955 *Anemia subcretacea* (Saporta): Chandler, p. 293.
1962 *Anemia subcretacea* (Saporta): Chandler, p. 40, pl. 5, fig. 3.

According to Gardner, well-preserved barren frond and pinnule impressions were formerly abundant east of Bournemouth Pier in Freshwater Beds decreasing in size and abundance westwards. He described and figured (1880, pl. 9, fig. 2) one almost perfect frond showing 'a double forking of the stipes and a tripinnate limb' (V.14972). The outline of the pinnae is oval and the sessile pinnules are almost decurrent at the base, or more rarely, shortly stipitate varying in outline from broad to linear-lanceolate, very acuminate at the apex with coarsely-toothed margins, laciniate-dentate to lobed, the lobes being acute or crenulate. Veins are slender and said to be close together but they may in fact be as much as 0·45 mm. apart. The midrib is slight or absent in the pinnules while the midrib of the pinnae is well marked. Texture coriaceous the nerves show repeated dichotomous forking, in general diverging from the midrib or central vein. Other figured Gardner material is V.14970-71 and V.14973, and unfigured material is V.15033–42, V.46000-07. Small carbonaceous pinnule fragments have been found at Branksome Dene (V.43692). They are so imperfect that it would have been difficult to recognize and reconstruct them without the help of Gardner's well-preserved impressions. They can however be matched exactly among Gardner's material (cf. Pl. 7, figs. 1, 2). In spite of the fragmentary condition due to their brittle coriaceous texture both texture and nervation are highly characteristic. The margins of the pinnule lobes are stiffened by a vein, for laciniation occurs along the course of the nerves giving the firm edge which is a typical feature (cf. Pl. 7, figs. 1, 2, 5). Gardner noted the absence of sori in his fronds deducing thereby that the fern was one in which fertile and barren pinnules were distinct. This was one of the facts used by him in his deduction of the relationship, another being the repeated dichotomous division of the stipes. *A. poolensis* Chandler was also recognized from the Bournemouth Freshwater Beds (cf. p. 38). It is represented by small tightly enrolled fertile pinnules with toothed sharply pointed lobes or segments similar in character to the barren ones of *A. subcretacea* but minute by comparison and relatively broader. Both *A. subcretacea* and *A. poolensis* have an epidermis of digitate cells. The fertile pinnules of the latter are commonly detached but sometimes two or three still remain attached as in the Lower Bagshot of Arne, Dorset, thus showing them to be parts of a dissected pinna with almost sessile pinnules. They

occurred in the raft of plant remains at Branksome Dene which yielded the barren carbonaceous fragments. Both barren and fertile pinnules have also been found at Arne. Inevitably the question arises whether *A. poolensis* is the fruiting organ of *A. subcretacea* and there seems little reason to doubt that this is so. It is improbable that the two will ever be found in organic

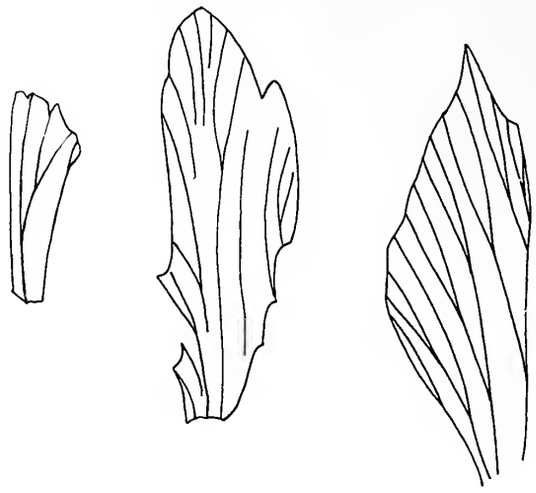


Fig. 7. *Anemia subcretacea* (Saporta). A, Pinnule fragment, cf. Pl. 7, fig. 5. B, Fragment of pinnule tip showing nervation, cf. Pl. 7, fig. 6. C, Pinnule fragment showing nervation, cf. Pl. 7, fig. 7. from Studland.

continuity now that excavation of the cliffs is no longer allowed. Fortunately Gardner was able to extract his fronds before the prohibition existed and the result is that his specimens display the perfect form of the barren pinnules and pinnae as it could never be shown by the brittle carbonaceous fragments alone obtainable today. It is no doubt the tightly enrolled character of the fertile pinnules which has enabled them to withstand battering and transport. Fragmentary carbonaceous barren pinnules have also recently been recognized in the Lower Bagshot at Studland (Pl. 7, figs. 5–7), at Arne (Chandler, 1962: 40, pl. 5, fig. 3) and at Lake (V.44998). Two specimens of barren pinnules in sandy matrix are in the Sedgwick Museum (Gardner Collection) and there is in addition a specimen labelled *Asplenium Foesteri*?

Anemia poolensis Chandler
forma fertilis of ***A. subcretacea***

1955 *Anemia poolensis* Chandler, p. 295, pl. 32, figs. 9, 10; pl. 33, figs. 28–30; pl. 35, fig. 41; pl. 36, fig. 58; text-fig. 2E, F.

1962 *Anemia poolensis* Chandler: Chandler, p. 41, pl. 4, figs. 43–46; pl. 5, figs. 1, 2.

The species was fully described by Chandler (1955), the bulk of the material being derived from the Lower Bagshot of Lake, Dorset and a few specimens from the Bournemouth Freshwater Beds as indicated above: V.31493, V.31516–17 from Sandbanks and V.31512–15 from Branksome Dene. In 1962 Chandler described and figured additional material from Arne,

Dorset (p. 41, pl. 5, figs. 1, 2) and Lake (pl. 4, figs. 43–46). Reasons for regarding these fertlie pinnules as the fertile form of *A. subcretacea* are given on p. 38.

It was suggested to the late W. N. Croft by N. Radforth and later to the author by R. A. Couper (personal communication) that the smoothness of the spores perhaps indicated immaturity as in Schizaeaceae the ornament is laid down very late. But it is difficult to explain the consistent occurrence of immature smooth spores in four different localities belonging to two distinct horizons and the absence of ornamented mature material. Possibly the smooth form is a primitive feature.

Gymnospermae

Order *CONIFERALES*

Family ARAUCARINEAE

Genus ARAUCARITES Presl, 1838: 203

Araucarites sternbergi Goeppert

Plate 1, figs. 1, 2, 4–13; Pl. 2, figs. 1–3, 6–10; Pl. 7, fig. 14; Text-fig. 8

1850 *Araucarites sternbergi* Goeppert, pl. 14, fig. 1.
1883 *Araucaria goepperti* (Sternberg): Gardner, p. 55 (1884), pl. 11, fig. 1; pl. 12.
1923 *Araucarites goepperti* (Sternberg): Bandulska, p. 248, pl. 20, figs. 13, 14.
1926 *Araucarites sternbergi* Goeppert: Florin *in* Reid & Chandler, p. 48.

Introductory note

The external characters of the twigs have been described and figured by Gardner and Bandulska. No cones or seeds were found unless a small cone-scale figured by Gardner (1883, pl. 2, fig. 21) tentatively referred to *Agathis* may belong to this species. Bandulska examined twigs and cuticle briefly describing the latter, allying the species with *Araucaria excelsa* rather than with *A. cunninghami* despite the greater superficial resemblance to the latter. She also drew attention to a resemblance to *Sequoia* and it was only after careful comparison of the Bournemouth material with both *Sequoia* and *Araucaria* that her conclusion as to the Araucarian relationship was reached. A second species of *Araucarites* was described by Florin (*in* Reid & Chandler, 1926: 48–51, pl. 2, figs. 6–19) from the Bembridge Beds under the name *A. gurnardi* (see also Pl. 1, fig. 3; Pl. 2, figs. 4, 5). Florin confirmed the Araucarian affinity in both species but no detailed comparison of the two cuticles was then published. A third species has now been described from beds between the Cuisian and Lutetian at Selsey as *A. selseyensis* (Chandler, 1961*a*: 19, 23, pl. 4, figs. 1–5; pl. 5; pl. 6). The cuticle of the Bournemouth *A. sternbergi* is now described in greater detail.

1. *Material from the Freshwater Beds*

Upper Surface (V.653*a*, V.16572*a*, *b*; Pl. 1, figs. 1, 6; Pl. 2, figs. 1–3)

The two facets on this surface of the long falcate leaf may be differentiated by the stronger cutinization of one of them giving it a denser appearance due no doubt to differential lighting.

A longitudinal stomatal band is present on each facet; it narrows towards the apex near which it dies out. Stomata in interrupted longitudinal rows, six to nine rows may lie abreast near the leaf base, four or five about the middle and near the apex there is usually one only. Stomata distributed somewhat irregularly, straight rows occurring only for short distances formed of from two to about five or six stomata. There are also isolated stomata flanked by epidermal cells above and below. Orientation of stomata chiefly oblique but sometimes transverse or longitudinal. Ordinary epidermal cell bands over the midrib and at the margins equal in breadth uniting at the leaf tip. In the marginal bands eight to twelve longitudinal lines of cells were counted but some large leaves show up to fifty lines. In the median row there are about twenty lines (many more in larger leaves). These epidermal cells vary in size and shape but are frequently broadest at the middle, narrowed to the extremities which may be pointed, oblique or rounded. Rectangular extremities and parallel-sided cells are the exception. Cell walls always straight not sinuous. Surface of cells with fine reticulations less conspicuous than those in *Taxodium lakense* (Chandler, 1962: 42, pl. 5, figs. 6–12; pl. 6, figs. 1–6; text-figs. 7, 8). Bandulska also recorded large, simple, round pits or papillae but these do not appear to be very conspicuous although they can be seen.

Within the stomatal bands the ordinary epidermal cells are similarly thickened, irregular in shape and orientation, frequently equiaxial or almost so. Between two neighbouring rows of stomata they are frequently, although not invariably, longitudinally aligned. Between adjacent stomata in the same longitudinal row there are often one or two epidermal cells with their long axes transverse even when the stomata are longitudinally or obliquely oriented. Stomata appear to possess no auxiliary cells in common but occasionally two in a row may be contiguous. These auxiliary cells are narrow, placed end to end to form a ring, sometimes a double ring, around the guard cells. Cells of inner ring from four to six, commonly five, often much thickened where they abut on the guard cells. Cells of the outer ring often coincide in length with those of the inner ring as if formed by division of a single cell. Guard cells thinly cuticularized, slit clear within the sunk oval or quadrangular outer pore which is about 0·03 to 0·04 mm. long (V.653*a*, V.16572*a*; Pl. 1, fig. 1; Pl. 2, figs. 1, 2). Other fragments show flat-topped pits or papillae irregular in size, shape and distribution on the ordinary epidermal cells (Pl. 2, fig. 3) not fine reticulations. These resemble similar structures seen in *Araucarites gurnardi* but in other fragments from this twig the reticulations are seen.

Lower Surface (V.16572*b*; Pl. 1, fig. 5)

Stomatal bands extend almost to the leaf tip and are broader than those of the upper surface with more sparsely distributed stomata. In each longitudinal row the stomata are more widely spaced and they tend to be smaller, the outer pore often only about 0·03 mm. long or less. Orientation of stomata longitudinal, transverse, or oblique, mostly oblique or longitudinal. Auxiliary cells tend to be narrower than on the upper surface. There may be as many as ten transversely elongate epidermal cells between two neighbouring stomata in the same row or the intervening cells may be more irregular in size, shape or arrangement. The ordinary epidermal cells in both median and lateral bands are usually more parallel-sided than on the upper surface, reticulate (V.16572) as in the auxiliary cells also, but sometimes pitted or papillate (V.653).

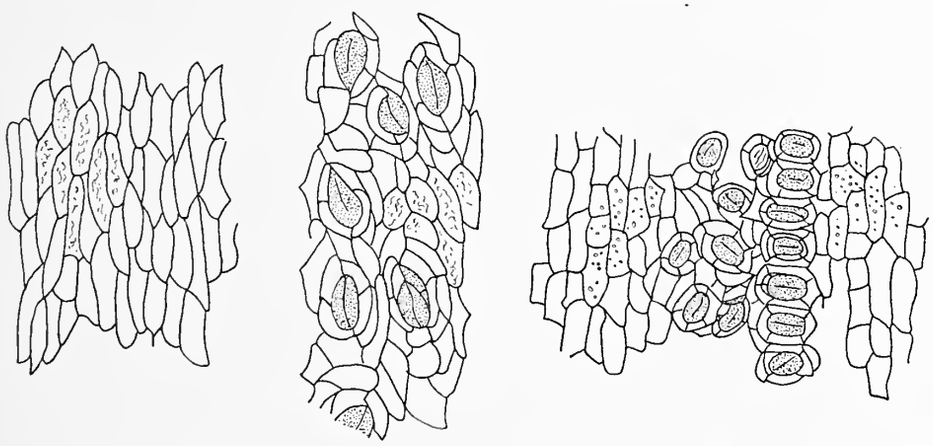
A single leaf of Araucarian type found at Sandbanks is quadrilateral in section with

much corroded surface. No cuticle could be prepared. Stomatal pores are seen in bands on each side of the median angle (Pl. 7, fig. 14).

2. *Material from the Marine Beds*

(*a*) *Detached leaf from Honeycomb Chine, Boscombe* (*Nipa* beds).
(Pl. 2, figs. 6–10)

This long four-angled falcate leaf has two equal facets on the upper surface. Length preserved about 3 mm.; maximum breadth, 0·85 mm.



1 2 3

Fig. 8. *Araucarites sternbergi* Goeppert, *A. gurnardi* Florin. 1. *A. sternbergi.* Part of band of ordinary epidermal cells in region near midrib in upper cuticle. Cells narrowed to extremities. The reticulate thickening of the cells (indicated diagrammatically) is of general occurrence throughout the band. End walls of cells oblique or angled. 2. *A. sternbergi.* Part of stomatal band of upper cuticle. 3. *A. gurnardi.* Part of stomatal band of upper surface for comparison with *A. sternbergi*, showing the approximately parallel-sided epidermal cells often with rectangular end walls. Rows of transversely aligned stomata a characteristic feature.
Figs. 1, 2 Bournemouth. Fig. 3 Bembridge Beds, Isle of Wight.

Upper Surface

The leaf tip shows two stomatal bands one each side of the midrib which narrow towards the apex finally dying out. The stomata are arranged in interrupted longitudinal rows and are widely spaced with longitudinal, oblique or transverse orientation, oblique predominating. The outer pore, about 0·025 mm. to 0·03 mm. long is sunk, guard cells thin, slit distinct. Adjacent stomata in same row separated by from one to several transversely oriented epidermal cells, the intervening cells here as between the longitudinal rows of stomata irregular in size, shape and arrangement, equiaxial or longitudinally elongate. Ordinary epidermal cell bands as described above but with rather rounded or irregular shaped cells, sometimes longitudinally elongate and tending to be elongate at the lower end of the cuticle fragment. These cells frequently broadest at the middle usually with rounded angles. Stomata as described above but more markedly thickened where they abut on the guard cells.

Lower Surface

Very fragmentary. Stomata in this example with a wider ring of auxiliary cells than on the upper surface and very marked ring of thickening around the guard cells. Stomata and ordinary epidermal cells as described, the latter longer relative to breadth near the margin than elsewhere, they tend to be square or oblique at their ends rather than angled.

(*b*) *Detached leaf from a leafy lenticle, cliff base, Southbourne.*
(V.43647; Pl. 1, figs. 4, 7–9)

The falcate leaf is markedly curved and somewhat laterally flattened. Cuticle obtained from the apical end is very dense.

Upper Surface

Ordinary epidermal cells long and narrow near the margins, narrowed somewhat at the two extremities, about fifteen rows of cells were counted. They show reticulate thickening. About seven interrupted lines of stomata are preserved, five to six and even nine lying adjacent in a single row with two to four lines of ordinary epidermal cells between the rows. These are as described above but narrowed to the extremities, rounded at the angles and reticulately thickened. Stomata as described above. Length of outer pore, 0·02 to 0·03 mm.

Lower Surface

Marginal epidermal cells tend to be broader than those of the upper surface, fifteen to seventeen rows are seen. Over the midrib there are about twenty rows of similar cells. Epidermal cells more commonly rectangular-ended than on the upper surface. Stomata as described but cells denser in the stomatal bands than those on the upper surface. Auxiliary cells broader radially than those on the upper surface the stomata being more rounded and less elongate. The ring of auxiliary cells is less frequently double. At the leaf tip the marginal and median bands of epidermal cells unite and the cells become conspicuously parallel-sided and square-ended.

(*c*) *A detached leaf from the Highcliff Sands, Cliff End, Mudeford.*
(V.43648; Pl. 1, figs. 10–13)

A poorly preserved, markedly four-angled falcate leaf 6·5 mm. long shows characters as described for the species so far as these could be seen but only shreds of cuticle could be obtained. The epidermal cells are usually inflated some narrowing to the extremities, others rectangular, all are rounded at the angles. Cell walls irregularly thickened.

Remarks and Affinities. Gardner recorded this species only in the upper part of the Bournemouth Freshwater Series and stated that it passed up into the Marine Beds. He had seen no trace of it west of the Pier but it abounded to the east which he regarded as indicating that it grew not far from the sea. The writer found a battered leaf at Sandbanks close to Poole Harbour. In certain beds of sandy mud in the Marine Series Gardner found the branchlets heaped together 'in perfect preservation' and crossing each other in every direction. Another interpretation than his is possible, namely that the twigs and branches were swept down from high land by the river in spate and dropped where the current slackened inside and outside the mouth of the estuary.

Florin (*in* Reid & Chandler, 1926: 50) pointed out that the name *A. goepperti* used by Gardner for this material was instituted for a detached and imperfect cone from older Tertiary beds at Häring, Tyrol (Presl *in* Sternberg, 1838: 203). Later, Goeppert (1850) described sterile twigs from the same locality as *A. sternbergi* which he considered might perhaps belong to the cone. It seems most probable that this was the case in view of the association of cones or cone scales of Araucarian type with this sort of foliage in the Bembridge Beds (Reid & Chandler, 1926: 48, pl. 2, figs. 6–19), at Selsey (Chandler, 1961*a*: 23) and the Alais basin (*Doliostrobus sternbergi*, Marion, 1888: 1–20, pls. 1, 2) where there is continuity between foliage and cones. If proof of this supposition becomes available it may be necessary to transfer the Bournemouth material to *Araucarites goepperti* but pending the discovery of further evidence this Bournemouth foliage is retained as *A. sternbergi* following the plan of Goeppert and, later, of Florin.

A comparison of *A. sternbergi* from Bournemouth with *A. gurnardi* Florin from the Bembridge Beds (Pl. 1, fig. 3; Pl. 2, figs. 4, 5; Reid & Chandler, 1926, pl. 2, figs. 6–19) shows that on the whole the ordinary epidermal cells of *A. sternbergi* are less parallel-sided and less rectangular-ended while usually the cell walls appear conspicuously reticulate and the papillae are often obscure. In *A. gurnardi* the papillae are a most conspicuous feature. In *A. sternbergi* transversely oriented stomata are not so common as in *A. gurnardi* where close-set lines of transversely oriented stomata are a most conspicuous feature of the upper surface of the leaf, while the number of stomata in an uninterrupted row may be larger than in *A. sternbergi*. These small differences impart to the leaves of the two species a distinctive appearance. Without the examination of a much larger range of cuticle preparation it would be unwise to state unreservedly that these distinctions are constant features but such evidence as is available suggests that they may be. Florin (*in* Reid & Chandler, 1926: 51) pointed out that the leaves of *A. gurnardi* appeared to be shorter, relatively broader, less falcate and usually more or less appressed while those of *A. sternbergi* were relatively long, narrow, somewhat spreading and falcate. The characters which distinguish *A. selseyensis* from these two species have been discussed by Chandler (1961*a*: 27).

The following are preserved in the British Museum (Natural History):

V.488 Figured Gardner (1888, pl. 12, fig. 1); Bandulska (1923, pl. 20, figs. 13, 14).
V.15115 Figured Gardner (1884, pl. 12, fig. 2).
V.15114 Figured Gardner (1884, pl. 11, fig. 1).
V.653a Figured Pl. 1, fig. 1; Pl. 2, figs. 2, 3.
V.16572 Figured Pl. 1, figs. 2, 5, 6; Pl. 2, fig. 1.
All from Freshwater Beds, Bournemouth.
V.43646 Figured Pl. 2, figs. 7–10.
From Marine Beds, Honeycomb Chine, Boscombe.
V.43647 Figured Pl. 1, figs. 4, 8, 9.
From leafy lenticle, Marine Beds, cliff base, Southbourne. Unfigured material: V.12644, V.10643, V.16572–73, V.6396, V.6398, V.43648–49, V.46009.

Family ABIETINEAE

Genus PINUS Linnaeus

Pinus sp.

Plate 7, figs. 10–13

DESCRIPTION. Fragmentary, rounded triangular or semicircular in transverse section, the dorsal surface being rounded. Longitudinal rows of almost contiguous large stomata measuring about 0·05 to 0·075 mm. occur on both surfaces, the rows themselves being in close proximity. The ordinary epidermal cells between the rows of stomata are oblong, longitudinally aligned, and about 0·016 mm. broad. The cuticle is so rotten and cracked that all attempts to make preparations were a complete failure. In addition to figured material there is V.43686. All are from the Highcliff Sands, Cliff End, Mudeford.

Family TAXODINEAE

Genus SEQUOIA Endlicher

Sequoia couttsiae Heer

Plate 7, figs. 15, 16

1862 *Sequoia couttsiae* Heer, p. 372, pl. 18, figs. 1–7.
1862*a* *Sequoia couttsiae* Heer, p. 1051, pl. 59; pl. 60, figs. 1–46; pl. 61.
1883 *Sequoia couttsiae* Heer: Gardner, p. 36.
1957 *Sequoia couttsiae* Heer: Chandler, p. 83.
1961 *Sequoia couttsiae* Heer: Chandler, p. 60, pl. 4, figs. 8, 9.
1962 *Sequoia couttsiae* Heer: Chandler, p. 20, pls. 1-3; pl. 4, figs. 1-32; text-figs. 1-6.

The species has been fully described and illustrated by Chandler, 1962. Gardner stated that it was 'rare in the dark clays and "Marine beds" of Bournemouth'. He gave no individual description or illustrations of Bournemouth material. A small twig (Pl. 7, fig. 16) was found recently between Alum and Middle Chines but cuticle could not be prepared. The closely imbricate leaves more resemble *Sequoia* than *Cupressistrobus* (p. 45). A single seed (V.43687) with characteristic striate and pitted surface was found at Sandbanks (Pl. 7, fig. 15) the pits about 0·012 to 0·016 mm. in diameter. It agrees in every detail with seeds from Bovey and Hamstead but has a peculiarly distorted S-shaped body. Such distortion is rare but was also seen in a Bovey seed. As the species is certainly present in the Studland beds below and the Bournemouth Marine Beds above there is every reason to suppose it persisted through the period represented by the Bournemouth Freshwater Beds. Typical material of leaves, cuticle, seeds and cone-scales was described and figured (Chandler, 1962: 32, pls. 1-4; text-figs. 1, 3, 4, 6) from a number of horizons in and above the Bournemouth Marine Beds. The following additional material is here briefly listed.

V.42338 Twigs. Leafy lenticle, cliff base, Southbourne.
V.44995 Twigs. Bournemouth Marine Sands, cliff base, Southbourne. East of ladder steps.
Twig fragments. Carbonaceous lenticle, base of Boscombe Sands about eight feet above dark sandy Bournemouth Marine Beds, east of ladder steps, Southbourne. Decayed.
V.42339–40 Twigs. Lignite above Boscombe Sands, Southbourne.
V.42341-42 Seeds and twigs. Highcliff Sands, Cliff End, Mudeford.

Family CUPRESSINEAE

Genus CUPRESSISTROBUS Chandler, 1961 : 61

Cupressistrobus gardneri Chandler (?*Cupressinites taxiformis* (Unger))

Plate 3, figs. 1–4, 8–32; Pls. 4–6; Text-figs. 9–11

1847 ?*Cupressinites taxiformis* Unger, p. 18, pl. 8, figs, 1–3; pl. 9, figs. 1–4.
1883 *Cupressus taxiformis* (Unger) Gardner, p. 26, pl. 1, figs. 1–13; pl. 5, figs. 13, 14; pl. 7, fig. 8; pl. 9, figs. 28, 29.
1883 *Taxodium europaeum* Brongniart: Gardner, p. 30, pl. 3, figs. 1–9; pl. 4, figs. 1–8 (in part at least).
1883 ?*Podocarpus*(?) *incerta* Gardner, p. 52, pl. 2, figs. 1–5.
1923 *Taxodium europaeum* Brongniart: Bandulska, p. 260, pl. 20, fig. 34; pl. 21, fig. 33.
1883 *Sequoia tournalii* Brongniart: Gardner, p. 40, pl. 5, figs. 1–8, 10–12 (in part at least).
1923 *Sequoia tournalii* Brongniart: Bandulska, pp. 256–7, 265, pl. 21, figs. 28–30.
1961 *Cupressistrobus gardneri* Chandler, p. 61.

Introductory Note

Owing to Gardner's determinations being based upon external morphological characters only there has been some confusion among the Bournemouth conifers leading to multiplication of genera and species. Supplementary evidence from cuticle fragments now demonstrates that certain specimens named *Sequoia tournalii* Brongniart and *Taxodium europaeum* Brongniart as well as unnamed coniferous twigs belong to the species referred by Gardner to *Cupressus taxiformis* (Unger) redescribed as *Cupressistrobus gardneri* Chandler. It is highly probable that the twigs described as *Podocarpus* (?) *incerta* (Gardner, 1883: 52,pl. 2, figs. 1–5) also belong to this species as they have the same distinctive and peculiar external morphology viz., laterally expanded bifacial foliage and narrow scale-like median leaves as in *Cupressistrobus gardneri* and '*Sequoia tournalii*'. However in this case no confirmation from cuticle could be obtained so the reference of *Podocarpus* (?) *incerta* to the species is only provisional.

The cuticle is so distinctive that it can be recognized from small fragments from all types of foliage and leaves (cf. Text-fig. 11 [14, 15]). In order to demonstrate the characters and to justify the inclusion of the supposed species named above it has been necessary to give the evidence in considerable detail.

Description. *Cone*: (V.15065–69) Gardner's cones were more complete than any recent finds and are described in the following words: 'ligneous and subglobose, broader than high, and 12 to 16 millimètres in diameter. The scales are eight in number, in four unequal pairs, subangular, four- or five-sided, depressed, and with strong wrinkles converging towards a sub-central mucro, and with slightly thickened and recurved edges. The four basal scales are sometimes trilobate and always coalesce into a single unequal quatrefoil round the footstalk, one pair, however, being relatively shortened. The next pair are opposite and five-sided, and the uppermost pair rather smaller, quadrate, and sometimes soldered together.' Two cones were figured from the Freshwater (Coastguard) Beds and two from the Marine Beds one of these being much compressed and distorted. The detached cone-scale (V.32108, Pl. 3, figs. 16–18) was about 7·5 mm. broad by 5 mm. high when complete but it unfortunately broke into three on removal from the matrix. It was pentagonal or possibly hexagonal, the apophysis

was borne somewhat asymmetrically on the slender stalk with which it was united near its lower margin. Its edges were sharply and obliquely faceted where it had been in contact with adjacent scales (Pl. 3, fig. 17). Surface of escutcheon flat, deeply wrinkled, the wrinkles forming a complex series of external grooves and rounded ridges which diverge from a point overlying the point of union with the stalk (Pl. 3, fig. 16). There is no marked mucro or umbo at the point of divergence as in Recent *Cupressus*. The scale appears identical in size and ornamentation with those depicted by Gardner. The shining external surface is formed of oblong cells, about 0·01 mm. in diameter, which diverge from the same point as the grooves and ridges. The faceted edge and the marginal area of the inner surface is of conspicuously convex, almost papillaeform, cells somewhat radially elongate and aligned. There are about three rows of these cells in a width of 0·1 mm. Preservation not good enough to show scars of attachment of seeds. 'Papillate' surface largely hidden except around the margin by a shining, smooth, finely-striate surface which ends abruptly more or less parallel with the margin (Pl. 3, fig. 18), puckered at its edge, pitted superficially and also ornamented with fine transverse or oblique striae. It has the appearance and texture of the wing of a seed or of its impression when a seed has been in close contact with the surface. An incomplete scale (Pl. 4, figs. 1, 2) about 5·5 by 3 mm. probably belongs to this species. There is also a second more abraded specimen (Pl. 4, figs. 3, 4) both from the Lignite above the Boscombe Sands, Southbourne.

Seed: Characters doubtful. A seed was depicted by Gardner (1883, pl. 7, fig. 8) and ascribed to this species but it showed no distinctive features.

(i) *External Morphological Features*

Foliage.

Polymorphic, spiral in young barren shoots but with two expanded lateral rows of leaves in older twigs the rest being relatively undeveloped and decurrent. Gardner noted that the bifacial foliage 'though generally separate, occasionally passes into the ordinary imbricated foliage on the same shoot'. He described the scale-like foliage as 'loosely imbricated and of various shapes, spiral, in apparently six rows, sometimes short and acute or obtuse-pointed, or longer, adpressed, and decurrent, awl-shaped, blunt, or acutely pointed, and occasionally spinous' (Gardner, 1883: 26). Laterally expanded leaves are from 3 to 15 mm. long. In regard to '*Sequoia tournalii*' Gardner remarked: 'The distichous foliage is like that of the Cupressus from the same locality, but much larger, coarser, more irregular, and of thicker substance. The longest leaflets measure twenty-two millimètres.' He added that the arrangement of the branchlets in the supposed *Sequoia* was irregular and they were often shed compound unlike those of *Cupressus* from the same bed while '*Sequoia*' also had imbricated as well as distichous foliage sometimes on the same twig. The barren foliage designated '*Taxodium europaeum*' by Gardner was said to be readily distinguishable from other Bournemouth conifers by its frequent branching. Its external characters were described both by Gardner (1883) and by Bandulska (1923). The leaves are imbricate, closely adpressed, decurrent, alternate, short and scale-like especially towards the base of the shoots, but longer near the tips, sometimes awl-shaped and recurved or expanding into flat linear leaflets, acute or obtusely pointed. Some of the recently collected imbricate twigs recall *Sequoia couttsiae* (cf. Pl. 3, figs. 26–28, 30).

They show much variation in the length of the free tips of the decurrent leaves and have free ventrilateral flanges extending for some distance below the adherent median ventral margin. A typical leaf is 1·2 mm. long. On the dorsal side where not overlapped by the leaves below, it is 0·8 mm. long on the free tip, 0·45 mm. broad from midrib to margin (or 0·9 mm. in total maximum breadth). A second type of imbricate twig is more readily distinguished superficially from *Sequoia* in that it displays some differentiation of the leaves giving a slight bifacial appearance. Such twigs have thinner flatter leaves with their two surfaces less superficially distinct. They are triangular and mucronate at the apex but less convex dorsally than those of the *Sequoia*-like foliage. The ventral surface is flat or concave, the dorsal has a slight median angle near the apex. A typical leaf is 1·4 mm. long where not overlapped by lower leaves, 1·1 mm. along the free tip and about 3·25 mm. from margin to margin. These leaves are decurrent but not so scale-like as those of the imbricate *Sequoia*-like foliage. They do not conspicuously embrace the twig (Pl. 3, figs. 29, 30). In the bifacial twigs the leaves appear to be spirally placed but certain of them are twisted so as to lie in one plane and in consequence they present an opposite or alternate laterally expanded appearance. There are two upstanding rows of small foliar leaves one dorsal the other ventral in the flattened branchlets. Both types of leaves are decurrent but the laterally expanded leaves are shed at a point where the free part of the leaf springs away from the decurrent base leaving a small projecting scar. The small median leaves are more persistent. Gardner's longest bifacial twig was 12 cm., 4 to 6 cm. being an average length. In the holotype only 2 cm. were preserved. Recent observations showed the following characteristics: Laterally expanded leaves linear or linear-lanceolate, from 3 to 20 mm. long or even longer, 0·9 to 2·25 mm. broad, narrowly attenuated to acute apically and sometimes mucronate, symmetric or asymmetric, these latter being twisted towards the tip during growth so that half the anatomical lower surface of the leaf has come to occupy the actual upper side and half the anatomical upper surface occupies the actual lower side of the leaf. In symmetric leaves the upper side is gently convex with a wide flat midrib extending throughout its length in a shallow groove. The under side is slightly concave with broad slightly convex midrib about 0·4 mm. wide and very slightly recurved margins. The small median leaves (Pl. 3, figs. 2–4, 15, 24, 25) are spathulate with entire margins, except near the pointed apex where there are sometimes slight sparse irregular denticulations. The base is gradually narrowed to the decurrent part. Lower surface with median convex angle throughout the length, upper surface angled convexly towards the tip, concave lower down; the midrib extends throughout the length. The free upstanding part of a typical leaf measures 3 mm.; breadth, 0·8 mm.

(ii) *Cuticular Characters*

All types of twig and leaf were examined. All show differentiation of the two surfaces and have stomata on both. No papillae are seen either inside or outside the stomatal bands. The degree of cuticularization varies with age, young leaves being very thin.

1. *Imbricate twigs with falcate scale-like leaves.*

Pl. 4, figs. 9–15, 17, 18; Pl. 6, figs. 5–7, 9; Text-fig 9$^{(1-5)}$, 10$^{(7)}$, 11$^{(1-5,\ 12-15)}$)

Cuticle denser on the lower than on the upper surface except at the extreme base of the leaf.

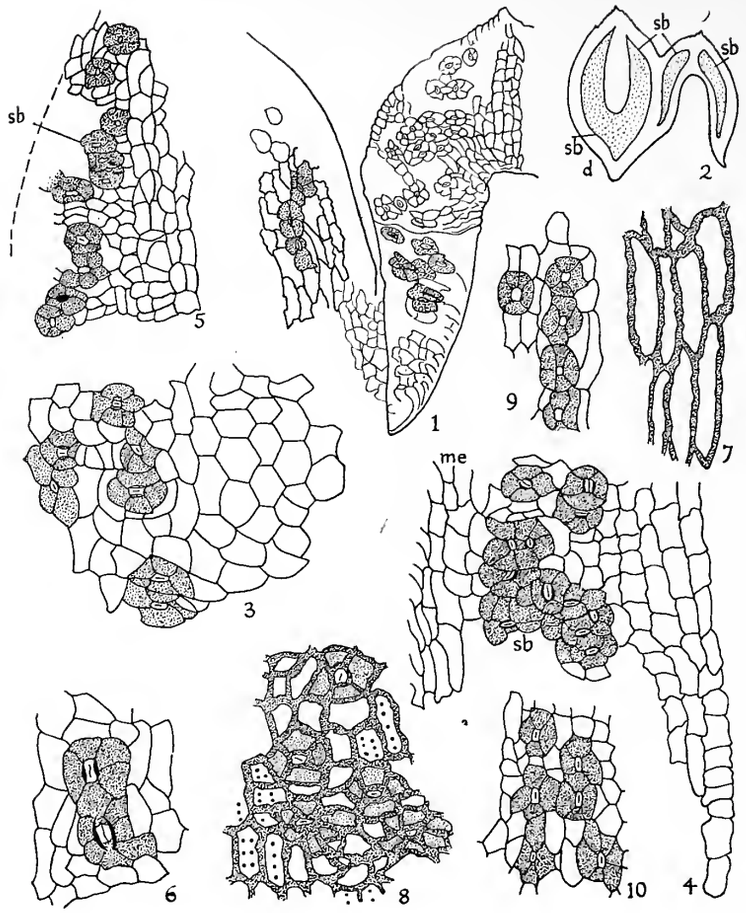


Fig. 9. *Cupressistrobus gardneri* Chandler. 1. Part of upper (ventral) cuticle of young falcate leaf showing free upper part (midrib and that which lies to the left of it) and the left lateral flange of decurrent part. The right-hand part of the dorsal cuticle is seen to the left of the upper showing somewhat elongate stomata and slightly sinuous auxiliary and epidermal cells towards the decurrent base. V.43666. 2. Diagram of more mature falcate leaf showing both surfaces with outlines of stomatal bands (dotted, *sb*) and the general arrangement of epidermal cells. The decurrent basal part occupies the lower half of both cuticles. *d*, dorsal; ventral surface to right. Based on material now destroyed. 3. Lower cuticle of short falcate leaf. Fragment showing part of left stomatal band and, on the right, epidermal cells over the median area. V.43667. 4. Part of upper cuticle of more mature leaf showing marginal epidermal cells, *me*, and those over the median area (right) some of which are slightly sinuous. Also part of left stomatal band, *sb*, with clustered stomata and pairs of scales where the guard cells abut on the lateral auxiliaries. V.43667. 5. Upper cuticle, to left side of midrib of young falcate leaf showing stomatal band, *sb*, near leaf tip. V.43668. 6. Detail of upper cuticle of small median upstanding leaf of bifacial twig (V.32108). It shows two adjacent stomata sharing an auxiliary polar cell, one with five, the other with seven auxiliary cells. It is situated a little above the middle of the leaf, left side. V.32108*c*. 7. Lower cuticle from flat leaf of an imbricate twig showing slightly uneven thickened walls of ordinary epidermal cells. V.43665. 8. Upper cuticle from same flat leaf. It shows part of the stomatal band with thick cell walls and ordinary epidermal cells with pitted walls within the stomatal band. In this type of leaf the auxiliary cells are seen to be scarcely more cuticularized than the epidermal cells beside them. V.43665. 9, 10. Two fragments from actual under surface of asymmetric broad laterally expanded leaf showing parts of stomatal band of the morphological under surface near the tip. Note the smooth rounded contours of the stomata in fig. 9. V.32108*b*.

Figs. 1–4, 7, 8 Sandbanks; Fig. 5 Branksome Dene; Figs. 6, 9, 10 between Branksome and Canford Chines, Bournemouth. All Bournemouth Freshwater Beds.

Lower Surface.

Diamond or lozenge-shaped. One young leaf measures 1·2 mm. by 0·6 mm. The numerous stomata are restricted to two stomatal bands in the upper part and sometimes throughout the length of the leaf but in some cases the bands merge over the lower part of the decurrent basal area (Pl. 4, fig. 15.). Stomata are usually in irregularly scattered groups or clusters of from three to a few, the groups separated by ordinary epidermal cells. A few stomata are solitary or in pairs; some are in short longitudinal rows. There are fewer stomata in the lower decurrent part of the leaf and in older leaves examined the usual mode of occurrence about the middle is in groups; nearer the apex there is a tendency for them to occur in longer or shorter longitudinal lines. In the free distal part of such older leaves stomata are usually somewhat longitudinally elongate and five auxiliary cells are common. Nearer the base there are four to five auxiliary cells, although four predominate, but these cells vary from four to six and occasionally there are seven. Diameter of typical stomatal apparatus including auxiliary cells, 0·035 to 0·075 mm.; outlines rounded or irregular, the cells often being denser and more cuticularized than surrounding epidermal cells (Pl. 4, fig. 11). Occasionally a polar auxiliary cell is elongate; sometimes two stomata share a single polar cell (Text-fig. $11^{(1)}$). In one instance two adjacent stomata one above the other share a polar auxiliary cell and an extended lateral auxiliary; in other instances the polar auxiliary cell of one stoma functions as a lateral auxiliary of an adjacent apparatus. Radial walls of auxiliaries are sometimes very slightly sinuous Outer pores of stomata are small, often about 0·012 mm. long, predominantly longitudinally aligned, sometimes oblique or transverse (Pl. 4, figs. 11, 12), slight cuticular thickening is evident along the outer margin of the guard cells against the auxiliaries. Occasionally the pore is completely obliterated by thickened scales of cuticle. Guard cells normally thin and clear with well marked slit. Epidermal cells between stomata or groups of stomata equiaxial or longitudinally elongate or aligned, often more or less rectangular, sometimes rounded, sometimes slightly sinuous especially over the axis of the leaf and near its basal margin. Bands of ordinary epidermal cells between the stomatal bands and along the leaf margins vary in breadth in different leaves. Epidermal cells of marginal bands long and narrow, tending to diverge at the extreme edge. In young leaves the margin of the free part is sometimes finely toothed or fringed, the teeth formed by the projecting ends of the divergent cells. In the median band epidermal cells are rectangular, longitudinally elongate below, but above the middle of the leaf they frequently develop a very typical appearance becoming equiaxial or sometimes even broader than long, quadrangular, hexagonal or pentagonal, about 0·02 mm. broad (Pl. 4, figs. 11, 12; Text-fig. $9^{(3)}$, $10^{(7)}$). Typical epidermal cells of marginal bands are longer and narrower than the elongate-rectangular cells of the median band. Some epidermal cells show pits on radial walls (Pl. 4, fig. 15). Cuticle from a decurrent leaf base (V.43681) shows parallel-sided epidermal cells sometimes five times as long as broad, angled, oblique or rectangular-ended. At the extreme base of this fragment the cells are equiaxial and a few scattered rosette-like stomata occur. Other stomata show auxiliary cells much extended longitudinally and guard cells with thick scales of cuticle.

Upper Surface.

Also with two stomatal bands which are triangular, broadest below dying out without uniting above. Bands continued onto decurrent free ventrilateral leaf flanges which correspond with the decurrent part of the dorsal surface. Stomata close, often in dense clusters,

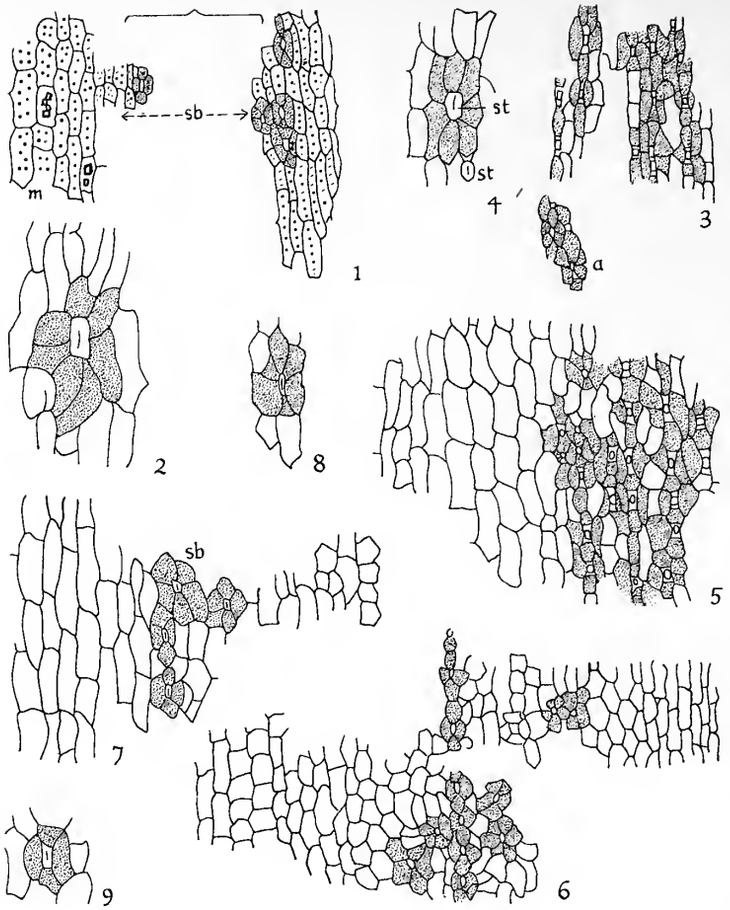


Fig. 10. *Cupressistrobus gardneri* Chandler. 1. Diagrammatic sketch of lower cuticle of broad laterally expanded leaf showing position of stomatal band between median, *m*, and marginal bands of pitted rectangular epidermal cells. About fourteen longitudinal rows of rectangular pitted cells (some with crystalline inclusions) overlie the median area and midrib (left). Cells about 0·02 mm. broad. About twenty-eight rows of cells form the stomatal band, *sb* (not drawn), and there is a marginal band of about twelve rows of pitted epidermal cells about 0·01 mm. broad (right). Based on V.32108*a*. 2. Stoma from lower cuticle of laterally expanded leaf, surrounded by seven auxiliary cells. Slide not now recognizable, cuticle broken in remounting. 3. Part of stomatal band of lower surface showing lines of stomata and tendency for auxiliary cells to be longitudinally elongate. Less elongate cells are seen at *a*. V.32108*a*. 4. Stoma with seven auxiliary cells from lower cuticle of broad laterally expanded leaf; *st*, stomatal apertures with guard cells. V.43668. 5. Part of stomatal band and marginal band of epidermal cells from lower cuticle of broad laterally expanded leaf. The apertures of the stoma with guard cells are about 0·01 mm. long. The elongation of the auxiliary cells is seen. Cf. with Fig. 3. V.43668. 6. Part of upper cuticle of broad laterally expanded leaf showing patches of stomata (less elongate than those of lower surface) and varied outlines of the epidermal cells. The margin of the leaf is on the right. The epidermal cells over the median area and midrib are to the left. V.43668. 7. Cuticle from lower surface of falcate leaf. The marginal band of ordinary epidermal cells is to the left. Part of the left stomatal band is seen, and the median band of epidermal cells is on the right. In many respects these cells and stomata are comparable with those seen in the upper cuticle of a broad laterally expanded leaf in Fig. 6 from Branksome Dene. V.43666. 8. Stoma with six auxiliary cells. Lower cuticle of a broad laterally expanded leaf at about the middle of its length. V.32108*a*. 9. Stoma with four auxiliary cells. Upper cuticle of the same.

Figs. 1–3, 8, 9 between Branksome and Canford Chines, Bournemouth; Figs. 4–6 Branksome Dene; Fig. 7 Sandbanks. All Bournemouth Freshwater Beds.

variously oriented many being longitudinally aligned especially towards the leaf tip. There are also many obliquely aligned and some transverse especially at the middle and the base of the leaf (Pl. 4, figs. 9, 10, 13, 17; Text-fig. 9(1, 4, 5), 11(4, 5)). On the decurrent flanges stomata are more densely distributed than on the free parts of leaves, the majority being elongate and longitudinally aligned. Other stomatal apparati here have rounded outlines presenting a rosette-like appearance due to the regular radial arrangement of the auxiliary cells (Text-fig. 11(12, 13)) but the outlines of yet others are oval or irregular (Text-fig. 11(4)). Towards the leaf tip stomata become more rounded with scarcely cutinized auxiliary cells whereas lower down the auxiliaries are often markedly dense and darker than surrounding cells. Auxiliary cells always smooth-walled, usually from four to six, occasionally seven, obscurely pitted. One abnormal stoma shows three cells only (Text-fig. 11(5)). In the upper part of the leaf five more or less equally developed auxiliaries often occur but six are not uncommon; in the lower part four are more usual. There are sometimes three polar auxiliary cells but normally two, the rest being lateral. Two adjacent stomata sometimes share one lateral auxiliary cell or a lateral auxiliary of one stoma may form the polar auxiliary of another, but most usually each stoma has its own independent set of auxiliary cells which are often contiguous with those of neighbouring stomata. Outer pore rounded, oval or rectangular, often about 0·04 mm. long, frequently larger than the pores on the lower surface, rounder on the whole towards the leaf tip than lower down. Those measured on the decurrent flanges are 0·02 mm. long. Guard cells thin, usually with a pair of scales where they abut on the lateral auxiliaries. Slit distinct. Ordinary epidermal cells within stomatal bands short and rectangular or quite irregular in shape, usually smaller than those outside the bands. Towards the leaf apex these cells show a marked tendency to be equiaxial, sometimes, especially towards the middle and base of the leaf, they are transversely elongate. All epidermal cells both inside and outside stomatal bands have finely pitted radial walls. Epidermal cells of median area between stomatal bands are commonly rectangular and longitudinally aligned. In one mature leaf there are eleven to twelve rows of cells near the leaf base some with slightly sinuous walls but in places four to five short, broad, adjacent cells occur instead. In a young leaf five or six rows of more or less rectangular, longitudinally elongate cells are seen with slightly sinuous walls. In the marginal bands in this leaf there are three or four rows of cells of varying shape the outermost being oblique to the margin. On the whole the epidermal cells of the lateral bands are longer and narrower than those of the median bands.

2. *Twigs with thinner flatter leaves and a tendency to be bifacial.*

(Pl. 5, figs. 1, 2; Text-fig. 9(7, 8))

The lower cuticle again denser than that of the upper.

Lower Surface.

Stomatal bands ill-defined with few scattered stomata which become more abundant towards the apex where groups of a few close-set stomata are seen (Pl. 5, fig. 2). Auxiliary cells four to six somewhat more cutinized than surrounding cells. Pores rectangular, oval or circular, small, commonly closed by dense brown cuticle, sometimes showing clear thin guard cells. Some stomata are longitudinally elongate. In others auxiliary cells form a rosette some cells being shared by adjacent stomata (V.43676). In the broad median band ordinary

epidermal cells are narrow, longitudinally elongate and aligned, some with rectangular, others with oblique or pointed ends. These cells frequently alternate in adjacent rows (Pl. 5, fig. 2; Text-fig. 9(7)). Some measure 0·04 to 0·06 mm. long and only 0·01 mm. broad. Marginal bands of epidermal cells narrow, the cells obliquely aligned near the leaf tip. All ordinary epidermal cells are very thick-walled with obscure irregular coarse pits (upper part of fig. 2 in Pl. 5).

Upper Surface. (Pl. 5, fig. 1; Text-fig. 9(8))

Stomata in two lateral bands which die out below the triangular tip, in slide V.32108*c* at about 0·28 mm. below, the breadth of this leaf being about 0·36 mm. In other leaves they extend throughout the whole length of the free part of the leaf. At the upper end of the leaf the stomata are close together in numerous groups separated by ordinary pitted epidermal cells (Text-fig. 9(8)). Lower down the groups are fewer with fewer stomata, sometimes only two to four, sometimes one. Many stomata are longitudinally or transversely aligned but some are oblique. Longitudinal orientation is commoner in the lower than in the upper part of the leaf where transverse orientation predominates. From four to six auxiliary cells are seen (Text-fig. 9(8)) and are somewhat more cutinized than surrounding epidermal cells and occasionally pitted. Two adjacent stomata sometimes share a polar or lateral auxiliary cell, or the polar cell of one stoma is a lateral auxiliary of a stoma near by. Pores small, rectangular or oval, with clear, thin, guard cells. Slit well defined. The median ordinary epidermal cell bands are about twelve cells wide in a leaf examined and the marginal cell band only six or seven cells wide. Median band with longitudinally elongate and aligned, rectangular, thick-walled cells conspicuously and regularly pitted, those in adjacent rows alternating; radial walls sometimes very slightly sinuous especially near the leaf tip where the cells are often shorter than at the middle or base of the leaf and sometimes as broad as long. Near the base these cells are narrow and elongate, 0·01 mm. broad and 0·06 mm. long; at the middle of the leaf they are often 0·02 mm. broad and 0·03 to 0·04 mm. long. Epidermal cells of the stomatal bands closely resemble those outside. Slide V. 43665 is important for it shows a cuticle from the upper surface of a young, free, somewhat flattened, leaf tip from the same twig as the cuticles just described. This is identical in character with the young leaf tip from a typical imbricate twig in slide V.43666 and thus supplies a connecting link between the somewhat bifacial twigs with flat leaves and typical imbricate twigs with scale-like leaves.

3. *Twigs with broad laterally expanded markedly bifacial foliage.*

(*a*) *Symmetrically developed broad leaves.* (Pl. 5, figs. 6–13; Pl. 6, fig. 4; Text-figs. 10(1–6,8,9), 11(6–11))

The two surfaces are quite distinct in character. In contrast to the imbricate type of foliage just described the more exposed upper surface has conspicuously thicker cuticle and fewer stomata than the lower.

Lower Cuticle. (Pl. 5, figs. 6, 7, 10–13; Text-fig. 10(1–5, 8))

There are two well-defined stomatal bands one each side of the midrib with thinner cuticle than in other parts of the leaf. One leaf (V.32108*a*) shows ten to twelve interrupted short parallel rows of stomata in each band (Pl. 5, fig. 6, Text-fig. 10(1, 3)). Other better preserved fragments from the same twig (V.32108*m*, *n*) and from Branksome Dene (V.43676, V.43688)

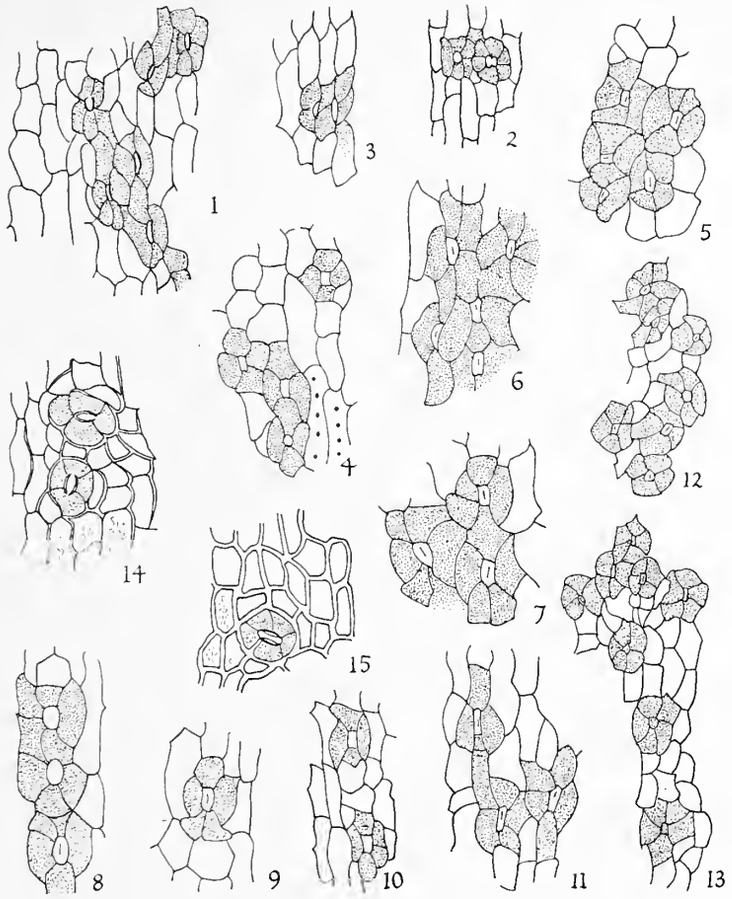


Fig. 11. *Cupressistrobus gardneri* Chandler. 1. Fragment of lower cuticle of Gardner's *Taxodium europaeum*, showing typical epidermal cells of median area and clusters of stomata. One cluster shows the tendency for auxiliary cells to be elongate and the sharing of a polar auxiliary cell by two stomata. V.15072*a*. 2. Another part of same fragment of cuticle showing two contiguous rosette-like stomata. Cf. Pl. 6, figs. 5, 6. 3. Another pair of stomata in the same fragment showing shared auxiliary cells. This pair lies to the right and a little below the stomata at *st* in Pl. 6, fig. 6 but are obscure in the figure owing to the condition of the specimen. 4. Curled fragment of upper cuticle from same twig on same slide. It shows stomata and pitting of ordinary epidermal cells. 5. Fragment of upper cuticle of falcate leaf showing group of stomata with four to five auxiliary cells and one unusual stoma with three such cells. V.43666. 6. Lower cuticle showing group of five stomata in one of the stomatal bands of broad laterally expanded leaf. A stoma with its own independent auxiliary cells can be seen and other stomata in which polar or lateral auxiliary cells are shared. In one case a polar cell of one stoma serves as a lateral auxiliary cell of another. Four to six auxiliary cells are seen. V.32108*a*. 7. Upper cuticle of same leaf showing three contiguous stoma having five to six auxiliary cells. Two share a polar auxiliary cell. 8. Upper cuticle of same showing three contiguous stomata with five auxiliary cells. 9. Upper cuticle of same showing a solitary stoma with five auxiliary cells. 10. Upper cuticle of same, showing two longitudinally aligned stomata of a row with four to five auxiliary cells. A pair of ordinary epidermal cells separate the two stomatal apparati. 11. Lower cuticle of same showing three stomata in a stomatal band with four to five auxiliary cells. A polar auxiliary cell of one stoma serves as a lateral auxiliary cell of another. Two stomata in adjacent rows have each their own auxiliaries. 12. Upper cuticle fragment from a falcate leaf showing rosette-like stomata with four to six auxiliary cells. V.43666. 13. Cuticle fragment, probably upper, from slender twig tip with small falcate leaves. V.43670, damaged in remounting. 14. Fragment of lower cuticle near base of falcate leaf showing rounded stomatal apparati with four auxiliary cells and a pair of scales at junction of guard cells and auxiliary cells. Specimen no longer extant. 15. Another fragment of same showing a stoma with five auxiliary cells and conspicuous scales. Figs. 1–4 exact locality unspecified; Figs. 5, 12 Sandbanks; Figs. 6–11 between Branksome and Canford Chines, Bournemouth; Fig. 13 Branksome Dene. All Bournemouth Freshwater Beds. Figs. 14, 15 Highcliff Sands, Cliff End, Mudeford.

show the lines of stomata even more clearly with about ten to twelve contiguous stomata in one unbroken longitudinal line (Pl. 5, figs. 10, 11). The majority of stomata are longitudinally oriented but a few oblique or transverse examples occur. The stomata are always thickly scattered, sometimes in adjacent rows without intervening epidermal cells (Text-fig. 10(3), 11(6)), sometimes with one or more lines of ordinary epidermal cells between the rows (V.43668). Some contiguous rows of stomata give rise to groups of four or five closely adjacent stomata with no intervening epidermal cells (Text-fig. 11(6)). One or more lateral auxiliaries are often shared (Text-fig. 11(6)) or each stoma may have its own auxiliary cells (Text-fig. 11(11)). The polar auxiliary cells of one stoma may serve as lateral auxiliary of a stoma in an adjacent row (Text-fig. 11(11)). Adjacent stomata in the same row sometimes share the same elongate polar auxiliary cell (Text-figs. 10(3, 5), 11(6)) but frequently there are two polar auxiliary cells between the pores of adjacent stomata (Text-fig. 10(3)) and in some instances there are intervening epidermal cells as well. Obvious differentiation into polar or lateral auxiliary cells does not always occur and there are one or two lateral auxiliaries along the side of the pore which tend to be elongate parallel with the leaf axis. An obscure transverse wall sometimes cuts off a small cell adjacent to the outer pore from the contracted ends of the polar cells (Text-figs. 10(3, 5), 11(11)). Outlines of the less closely situated stomatal apparati can be very irregular owing to the unequal size and shape of the auxiliary cells (Text-fig. 11(11)) or can be longitudinally elongate owing to the prolongation of some or all of the auxiliaries parallel with the axis of the leaf. Other stomata are regularly rounded and rosette-like in cases where the polar and lateral auxiliary cells show no differentiation of form. The normal number of auxiliaries is four to six but there are occasionally seven (Text-fig. 10(2)); five are common. They arise more or less radially around the pore and their cuticle is often slightly thicker than that of the surrounding ordinary epidermal cells. Outer pore rectangular, oval, or polygonal, occasionally almost circular, about 0·01 to 0·015 mm. long. Guard cells clear and colourless with well defined slit and a pair of scales or thickenings at the junction of guard cells and lateral auxiliaries. The marginal bands of ordinary epidermal cells are narrower than the median band and this may be scarcely wider than the stomatal bands. Forty-two lines of cells occur over the midrib and nine to twelve lines at each margin in the leaf from the holotype, while another leaf fragment shows twenty-six lines at the margins. These epidermal cells are rectangular or oblong with transverse or oblique end walls and usually rounded angles giving a somewhat sinuous appearance to the longitudinal rows. Cells three to five times as long as broad (Text-fig. 10(1)), narrower at the leaf margins than over the midrib itself where they are frequently oblique or angled at their ends, straight-sided and without much rounding of their angles with the cells of adjacent rows not regularly alternating. Elsewhere in the median band as in the marginal bands the cells of adjacent longitudinal rows alternate with considerable regularity producing a highly characteristic appearance. Rarely do the transverse walls show slight sinuosities. Ordinary epidermal cells regularly and thickly pitted, the pitting producing a finely sinuous effect. Ordinary epidermal cells within the stomatal bands normally shorter than those outside. A few epidermal cells appear to show large crystalline inclusions (Text-fig. 10(1)).

Upper Cuticle. (Pl. 5, figs. 8, 9; Pl. 6, fig. 4; Text-figs. 10(6, 9), 11(7–10))

Upper cuticle formed almost entirely of ordinary epidermal cells but with a few scattered stomata. There are no distinct stomatal bands with thickly scattered stomata as in the lower

cuticle. Stomata are usually more rounded than on the lower surface, mostly grouped in two or three interrupted longitudinal rows, occasionally isolated (Pl. 5, fig. 8; Text-figs. 10(9), 11(9)). Sometimes as many as eight stomata are seen in a line with one, two or no epidermal cells between the individual stomata of the row. As few as two are sometimes adjacent. One or two stomata are seen on the edge of the midrib (V.32108*a*), one slide showing at least one interrupted line of stomata on each side of the midrib. Near the margin of a leaf there are a few slightly obliquely orientated stomata in a longitudinal row. Normally the orientation is longitudinal (Text-fig. 10(6)). In places two short longitudinal rows of several stomata lie adjacent without intervening ordinary epidermal cells. Auxiliary cells are noticeably thicker and darker than surrounding epidermal cells. Two stomata in the same row are seen to share a polar auxiliary cell (Text-fig. 11(7, 8)). Lateral auxiliary cells are commonly shared. Of the four to six auxiliary cells normally seen there are usually two at the poles and two or three at the sides of the pore, and in a number of instances the lateral auxiliary cells are somewhat elongate and longitudinally aligned. The outer pore is 0·006 to 0·01 mm. long. The guard cells are clear and colourless, separated by a marked slit. Ordinary epidermal cells are rectangular, square, or more rarely oblique at their ends and usually somewhat rounded at their angles (Pl. 5, figs. 8, 9) except over the midrib and at the extreme margin. In places they appear slightly and coarsely sinuous. One leaf of the holotype shows about twelve rows of cells over the midrib while those of the marginal bands, although similar, are relatively narrower and longer. Reticulation of the surface is sometimes seen. Two rows of pits in the cell walls are visible in many leaves. In parts of the leaves characteristic hexagonal or polygonal equiaxial cells occur (cf. Pl. 6, fig. 4; Text-fig. 10(6) cf. V.43668). These cells closely resemble those of the lower (i.e. more exposed) cuticle of the imbricate leaf tips from Sandbanks (cf. Pl. 4, figs. 11, 12; Text-fig. 9(3), V. 43667) and form a connecting link between the imbricate and bifacial types of foliage. Stomata on V.43670 from Branksome Dene are also identical in character with those of V.43666 from Sandbanks. Also in both cases the typical rectangular cells with rounded angles are developed in parts of the same cuticle fragment (V.43667) or in cuticle from the same twig.

(*b*) *Asymmetrically developed broad leaves.* (Pl. 5, figs. 3–5; Text-fig. 9(9,10); V.32108*b*)

A leaf tip which has become twisted during growth shows the junction between the morphological upper and lower surfaces lying approximately along the median line of the flat leaf blade as developed by twisting. The degree of twisting varies in different leaves. In much twisted leaves the difference between the cuticles of the actual upper and lower surfaces is less marked than the difference between the two surfaces of symmetric untwisted leaves. In the main it is a difference of thickness and degree of cutinization. The stomata of the two surfaces are closely comparable and more akin to those of the imbricate leaves than to the typical stomata of the lower surface of symmetric broad leaves. As would be expected the cuticle of the whole upper surface of the twisted blade which has been the more exposed is the slightly thicker of the two surfaces although in both half the blade represents the true morphological under surface and half the true upper surface. The under side shows obscure rows of pits on the epidermal cells (Pl. 5, fig. 3).

(i) *Morphological lower cuticle on upper surface of leaf blade.* (Pl. 5, figs. 4, 5; V. 32108*b*)

A broad stomatal band divides into two towards the leaf tip, the two being separated by

about four or five rows of rectangular epidermal cells. Stomata are somewhat irregularly distributed, sometimes almost contiguous transversely and longitudinally, sometimes completely isolated, groups of stomata are separated by square or elongate epidermal cells, occasionally elongate transversely. Orientation of stomata is usually longitudinal, sometimes oblique, occasionally transverse. Auxiliary cells dark through much cutinization, typically four to six, very occasionally seven. The outer pore is oval or rectangular, more rarely rounded.

(ii) *Morphological lower cuticle on under surface of leaf blade.* (Pl. 5, fig. 3; Text-fig. 9(9, 10))

Here the stomatal band has more thickly scattered stomata with more rectangular pores and their orientation is almost always longitudinal. Auxiliary cells are frequently four. Two neighbouring stomata in a row sometimes share a polar auxiliary cell or an outer polar auxiliary cell. Sometimes each has a polar auxiliary cell with no intervening epidermal cells or outer polar auxiliary. There are one or two lines of epidermal cells between adjacent rows of stomata in some instances, in others the lines of stomata are contiguous with no outer lateral auxiliary cells. So far as seen there are four to six auxiliary cells but in one exceptional case there are three only (V.32108*b*).

(iii) *Morphological upper cuticle on both sides of leaf blade.* (Pl. 5, figs. 3, 4)

Formed of rectangular or elongate cells with rounded corners or bevelled ends, and finely reticulated radial walls. Pits are present but obscure (Pl. 5, fig. 3). Cells of the leaf margin are narrower than those over most of the blade. There are a few scattered stomata usually in short lines near the leaf margin.

(*c*) *Small upstanding median leaves.* (Pl. 6, figs. 1–3; Text-fig. 9(6); cf. V.32108*c*, V.43673)
Lower Cuticle.

Lower more exposed cuticle is conspicuously thicker than the upper. Its stomata are somewhat irregularly scattered on both sides of the midrib except towards the base of the free portion where they are concentrated in two bands. Most stomata are longitudinally aligned. Near the leaf base the outer pore is round or oval (Pl. 6, fig. 2); at the middle and upper end it is frequently rectangular. It is often completely blocked by thick dark cuticle especially near the leaf base. Cuticle of auxiliary cells is thicker than that of surrounding cells, there are commonly five, sometimes four or six, so far as seen. Epidermal cells are longitudinally elongate or aligned with rectangular, bevelled, or angular ends, rounded angles and thickly pitted radial walls, the pits being most conspicuous at the leaf tip and arranged in longitudinal rows. Among the stomata the epidermal cells are like those of the rest of the cuticle except at the lower end in the more crowded stomatal band where they are often equiaxial instead of elongate but frequently quite irregular in shape. The epidermal cells of the leaf margin are narrower and more cuticularized than those elsewhere. Cell walls particularly thick at the base of the leaf over the midrib where obscure fine reticulate thickening is seen.

Upper Cuticle. (Pl. 6, figs. 1, 3; Text-fig. 9(6))

Stomata in two bands one on each side of the midrib with three or four rows of stomata within each band. The bands die out towards the apex. Stomata are longitudinally, transversely, or obliquely aligned. Four to seven auxiliary cells, commonly five, surround an oval or rectangular pore. Stomata of adjacent rows are sometimes contiguous without intervening

epidermal cells, but sometimes short, square, transversely or longitudinally elongate epidermal cells are present. The stomata of the same longitudinal row are contiguous, or separated by a variable number of epidermal cells, sometimes two to four or more often transversely elongate. Outside the stomatal bands are the usual three regions of ordinary epidermal cells which are rectangular or bevelled, often with rounded angles and broader over the midrib than elsewhere especially at the apex where they are frequently square or shortly rectangular. Over the marginal regions they are narrower and there are several rows of longitudinally elongate cells. At the base over the midrib the cells are peculiarly thin.

4. *Very young imbricate twigs from the Marine Beds, eighty yards east of the East Cliff Lift, Bournemouth.* (Pl. 4, figs. 6–8, 17, 18; Pl. 6, figs. 8, 9; Also V.43662)

Only minute fragments of tender almost diaphanous young cuticle could be obtained. They show characteristic rosette-like stomata, isolated or in contiguous groups of two or three. There are usually four or five radially arranged auxiliary cells surrounding the small thin guard cells of the angular, rectangular or oblong pore. Pore longitudinally, obliquely or occasionally transversely aligned, and about 0·01 mm. long. The whole stomatal apparatus is about 0·03 mm. long. One fragment shows stomata with auxiliary cells unequally developed so that the rosette-like symmetry is lost. Some stomata have their own auxiliary cells, but adjacent stomata sometimes share an auxiliary. These cells are only very slightly more cuticularized than the surrounding epidermal cells. Some of these latter show obscure reticulate thickening. They are longitudinally elongate, parallel-sided, angled, oblique or rectangular at their ends. Those in adjacent rows sometimes, but not invariably, alternate.

Remarks and Affinities. V.15103 is of great importance for it is a bifacial laterally expanded twig figured by Gardner (1883, pl. 5, fig. 12) and Bandulska (1923, pl. 21, figs. 28–30) as *Sequoia tournalii*. Slides V.15103*a*, *b*, (Pl. 4, fig. 16; Pl. 5, figs. 12, 13) prepared by Bandulska from this specimen provide evidence for identifying Gardner's supposed '*Sequoia tournalii*' with his *Cupressus taxiformis* (now included in *Cupressistrobus gardneri*). Fragments of cuticle from a laterally expanded leaf show the characters described above. The fragment in Pl. 4, fig. 16 comes from a decurrent leaf base (see description of Plate). Other evidence for this determination is afforded by V.21872 and slide V.21872*a* of Bandulska. Of comparable importance is V.15072 figured by Gardner (1883, pl. 3, fig. 3), a slender imbricate twig named by him '*Taxodites europaeus* Brongniart'. Cuticle on slide V.15072*a* from this specimen is figured on Pl. 6, figs. 5–7; Text-fig. 11(1–4), also figured by Bandulska (1923, pl. 21, fig. 33; pl. 20, fig. 34). Again the cuticle structure indicates *Cupressistrobus gardneri*. See also V.12072*b*. The same evidence of identity is afforded by unnamed conifer remains in the Gardner Collection. Thus V.12658 yielded typical although small fragments of cuticle seen on slides V.12658*a*, *b* and slides V.12654*a–e* show typical structures some from laterally expanded leaves. Gardner recorded '*Cupressus taxiformis*' from the higher beds of the Bournemouth Freshwater Series and the Bournemouth Marine Beds above. By the discovery of new material and the uniting of *Sequoia tournalii* and *Taxodium europaeum* (in part at least) the range in the Freshwater Beds is now considerably extended (see below for details of distribution). The cones came from the Freshwater Beds ('Black Bed' of 'Coastguard Beds') and Marine Beds. Imbricate foliage bearing cones was found and bifacial

twigs were joined to imbricate foliage. Hence the connexion of cones and the two types of foliage appears to be clear. Thin very young cuticle from imbricate twigs has recently been found also. There are about 120 unlisted registered specimens, 50 figured by Gardner.

The barren bifacial foliage differs from any living Cupressinaceae in its expanded lateral leaves and small foliar dorsal and ventral leaves. However it must be remembered that similar external form may be adopted by unrelated types and it is therefore not impossible for a species to have existed which differed in external habit from the living representatives of a family. The cuticles in fact afford valuable support to Gardner's opinion that the remains of his supposed '*Cupressus*' belonged to Cupressinaceae. In the first place the presence of stomata on both leaf surfaces appears to exclude relationship with hypostomatous forms such as Taxaceae, certain Podocarpaceae, Cephalotaxaceae and certain Pinaceae. It also excludes relationship with epistomatous types of Pinaceae and Podocarpaceae, with Sciadopityoideae and Juniperoideae and with the extinct *Pilgerodendron* Florin. Most of these are also excluded by the number of their auxiliary cells (four to six) and the arrangement and form of their stomatal apparatus. There remain the Cupressinaceae and Taxodioideae in which the stomata have four to seven auxiliary cells on their amphistomatous leaves. Seven auxiliary cells have been seen in a number of instances in the fossil although they are relatively rare (V.21872*a*, V.43673–74, V.43681). Structure and form of stomata considered in detail point to relationship with Cupressinaceae rather than with Taxodioideae. In Taxodioideae, the auxiliary cells normally form a ring with more regularity of outline than is usual in Cupressinaceae. In Cupressinaceae the outline of the auxiliary cells is in many cases irregular owing to the unequal length of the radial axes of these cells. This is also true of the stomata in the fossils under consideration. In the Cupressinaceae, as in the fossils, auxiliary cells between stomata closely adjacent laterally may be contiguous, or a single lateral auxiliary may be shared by the two adjacent stomata, the polar auxiliary cell of one stoma may function as a lateral auxiliary of another. Again, between two adjacent stomatal pores in the same longitudinal row there may be two polar auxiliary cells (i.e. one to each stoma) or only one auxiliary between the two and that one markedly elongate. Another feature common to the Cupressinaceae and the fossils is the conspicuous elongation of one or more lateral auxiliary cells, a lateral cell being sometimes elongate and curved in such a manner as to take its place in a series of ordinary epidermal cells between two rows of stomata. In many instances two lateral auxiliary cells project far beyond the polar cells. On the whole the longitudinal alignment and elongation of the stomata is less marked in the Cupressinaceae than in the fossil, but this feature is chiefly developed in the large laterally expanded leaves not found in the living whereas the alignment and orientation of the stomata in the small median leaves and the imbricate falcate twigs is irregular. Both the Cupressinaceae and the fossil show a marked pitting of the radial walls of ordinary epidermal cells, but in many Cupressinaceae highly conspicuous numerous papillae are a striking feature. These are absent in the fossil but also in the living genera *Actinostrobus*, *Fitzroya* and *Callitropsis*. Cones of the last named have not been seen but its stomata have only four to six auxiliary cells. Cones of the first two named genera are unlike those of the fossil and the cuticle of *Fitzroya* is also quite distinctive. (Above information about living conifers from Florin, 1931.)

It remains therefore to decide whether the fossil should be placed in *Cupressus* itself, or referred to an extinct genus of the Cupressinaceae distinguished by the external form of

some of its barren twigs, non-papillate cells, relatively regular longitudinal alignment and elongation of stomata on the laterally expanded leaves, and perhaps also by the striking regular outline of stomata with commonly only four auxiliary cells near the tips of twisted laterally expanded leaves. Its cones may also be distinguished by the slender stalk of the cone-scales. After weighing of the evidence it appears most reasonable to place the fossils provisionally at least in a new genus *Cupressistrobus* of the family Cupressinaceae. Whether or not the Bournemouth species is identical with *Cupressinites taxiformis* Unger is uncertain as the cuticle of Unger's species is not known. It is therefore treated as distinct and the name *Cupressistrobus gardneri* given as a tribute to Gardner's pioneer work on the Bournemouth material.

A close scrutiny of Gardner's figures and descriptions of *Podocarpus elegans* de la Harpe from the Lower Bagshot of Alum Bay suggests that some of these impressions may belong to *Cupressistrobus gardneri*. There is the same combination of imbricate twigs (Gardner, 1883: 50, pl. 8, figs. 1, 3, 13, 15) with bifacial twigs having laterally expanded leaves and small median leaves (Gardner, 1883: 50, pl. 8, figs. 4, 5, 8, 10, 10*a*) also showing decurrent leaf bases. Although the impressions are not so clear cut as they appear to have been when studied by Gardner there seems no adequate grounds for doubting his explicit statements and clear figures. It is unlikely that the alleged small median leaves merely represent decurrent leaf bases from which the leaves have fallen, for although such bases project at their distal ends giving therefore deeper impressions distally than proximally these distal ends in living conifers examined are truncate, blunt or rounded e.g. in *Podocarpus*, *Taxus* and *Sequoia*. In the Alum Bay fossil they are pointed and the outlines of the supposed median leaves may be elongate-oval whereas the outline of decurrent bases is usually more or less parallel-sided. Plate 3, figs. 2–4 from Bournemouth showing the impression of broad laterally expanded leaves and of a small median leaf on the holotype (represented originally by the carbonaceous leaves themselves also) may be compared with Pl. 3, figs. 5, 6 from Alum Bay where in V.14792 comparable impressions are shown (also figured Gardner, 1883, pl. 7, fig. 14). See also V.14785 figured Gardner (1883, pl. 8, fig. 10) and counterpart. A median leaf with elongate oval outline is shown at *ml* on the lower part of this twig. Pl. 3, fig. 8 shows a Bournemouth specimen with undoubted median leaves at *ml*. If further confirmation is needed it is perhaps supplied by the unmistakable presence in the Lower Bagshot of Dorset of a fine twig with well defined projecting median leaves preserved in the Dorset County Museum.

Why Gardner, who had recognized the two types of leaves at Bournemouth and Alum Bay, should have separated the material from these two localities is not clear. In both the leaves have obscure median nerves whereas in living *Podocarpus* the median nerve is a most conspicuous feature. Gardner's figures show exactly comparable twigs from both regions in regard to the degree of crowding and overlapping of the leaves and the absence of this feature. Supposed parallel nerves in Alum Bay leaves, seen also by Gardner in '*Sequoia tournalii*', are mere longitudinal striae caused by shrinkage of cuticle with its longitudinally aligned cells and rows of stomata. The same appearance is seen in carbonaceous leaves from Branksome Dene, Bournemouth (Pl. 3, fig. 19) but the cause is more readily detected than in the Pipe-clay impressions. There is little difference in size between the leaves from the two localities. Gardner described those from Alum Bay as having apices which taper to a point or are bluntly rounded and those from Bournemouth as acute sometimes mucronate with symmetric or asymmetric apices. However the Bournemouth '*S. tournalii*' are parallel-

sided and end in a bluntly mucronate point. Their longest leaves measure 22 mm., those of '*Podocarpus*(?) *incerta*' 30 mm., those of *P. elegans* from Alum Bay 12 mm. The Bournemouth '*Cupressus*' laterally expanded leaves were said to be from 3 to 15 mm. long. The occurrence of the same conifer on the mainland and in the Isle of Wight is most probable if, as the evidence indicates, the species is in the Lower to Middle Bagshot. Also found in the Woolwich Beds.

Angiospermae

MONOCOTYLEDONES

Family POTAMOGETONACEAE

Genus POTAMOGETON (Tourn.) L.

Potamogeton pygmaeus Chandler

Plate 7, figs. 17–21

1925 *Potamogeton pygmaeus* Chandler, p. 13, pl. 1, fig. 3.
1926 *Potamogeton pygmaeus* Chandler: Reid & Chandler, p. 66, pl. 3, figs. 20–22.
1961*b* *Potamogeton pygmaeus* Chandler: Chandler, p. 103, pl. 24, figs. 3-6.

Description and Remarks. A much worn endocarp, 1·25 mm. long, 0·75 mm. broad with germination valve missing and the ends of the limbs separated through abrasion is geologically the earliest record of this species. It comes from the Bournemouth Freshwater Beds at Branksome Dene (Pl. 7, fig. 17). In the succeeding Bournemouth Marine Beds and at later horizons endocarps are abundant some with and some without valves and spines, spine-bases only being seen in most specimens. They vary in length from 0·95 to 1·3 mm. excluding the spines and in breadth are about 1·1 mm. including the keel. When the endocarp is incomplete or much worn the curved seed within is exposed showing the testa formed of cells about 0·0125 mm. in diameter aligned parallel with the curvature. V.43108–09 are from the hard Bournemouth Marine Sands, cliff base, and V.43110–11 from a Leafy lenticle at the same horizon. One endocarp (V.43112) was found in a carbonaceous lenticle at the base of the Boscombe Sands and seven (V.43113–16) came from the lignitic raft above these Sands. All are from Southbourne. V.43117 is from the Highcliff Sands, Cliff End, Mudeford.

Endocarps and seeds agree in form and cell structure with those described from the Lower Headon of Hordle and the Bembridge Beds, Isle of Wight. The species occurs both in freshwater and estuarine beds at these two horizons so its appearance in force with the onset of marine conditions at Bournemouth may mark the rapid development of a vigorous new species rather than the change in physical conditions.

Genus LIMNOCARPUS C. Reid emend. Reid & Chandler, 1926:68

Limnocarpus forbesi (Heer)

Plate 7, figs. 22–26

1961*a* *Limnocarpus forbesi* (Heer) Chandler, p. 28, pl. 7, figs. 22–24.

Remarks. In the coast section of Dorset and Hampshire this genus and species has not yet been found below the Bournemouth Marine Beds where it appears in some profusion. Germination valves occur in the hard sands at the base of the Southbourne cliffs (V.43118) and at least a dozen crushed endocarps were found in the lignites immediately above these sands, i.e. at the base of the Boscombe Sands (Pl. 7, figs. 22, 23) and V.43121–24. From the Lignites above the Boscombe Sands others were obtained (Pl. 7, fig. 24) and V.43125, while in the younger Highcliff Sands at Cliff End, Mudeford, there were a few specimens (Pl. 7, figs. 25, 26) and V.42138–39. Published records extend the range into still higher beds at Hengistbury and Barton (Chandler, 1960: 205, 222, pl. 30, figs. 16, 17; pl. 33, figs. 84–86), the Lower Headon of Hordle (Chandler, 1925: 13, pl. 1, fig. 4*a–c*; text-fig. 3; 1961*b*: 104, pl. 24, figs. 7-11), the Upper Headon of Colwell and the Hamstead and Bembridge Beds (Reid & Chandler, 1926: 70, pl. 4, figs. 1–3 where some earlier references are given).

Apart from this stretch of coast and the Isle of Wight the only other locality where the species has been recognized is the Selsey area (Chandler, 1961*a*: 28, pl. 7, figs. 22–24) at an horizon on the boundary (approximately) of the Lutetian and Auversian. In the same paper an internal cast regarded as doubtful since the surface characters were not seen was figured from Cuisian Beds of Whitecliff Bay, Isle of Wight (p. 21, pl. 7, figs. 20, 21). Like *Potamogeton pygmaeus*, *Limnocarpus forbesi* abounds in estuarine and freshwater beds but is absent in the older Freshwater Beds of the Lower Bagshot and Bournemouth Freshwater Series. The reasons for now assigning the species to *L. forbesi* instead of to *L. headonensis* are discussed by Chandler (1961*a*: 28). The species reached its maximum development in the Lower Headon occurring in certain layers so abundantly as to blacken the surface of the beds.

Family ALISMACEAE

Genus ALISMA Linnaeus

?*Alisma* sp.

Plate 7, figs. 27, 28

Description. *Carpel*: Cuneate in transverse section, semi-oboval in outline; style subapical, terminal on the straight ventral margin and directed obliquely upward, patent, stiff, lateral faces slightly unequal in breadth (0·82 and 0·01 mm. broad respectively); apex rounded, dorsal face slightly convex transversely in the lower half without dorsilateral ribs (the apparent rib on one margin being due to distortion and compression of the dorsal face against the broader lateral face), base obliquely truncate, thickness of pericarp about 0·025 mm.; dorsal surface crumpled longitudinally, the crumples forming elongate hexagonal areas; lateral faces showing small equiaxial cells about 0·025 mm. in diameter causing transverse striations which become

oblique in the upper part of the carpel and which follow the curve of the dorsal surface near the apex; the surface also shows fine longitudinal striations, about 0·012 mm. apart. Length of carpel, 1·7 mm.; breadth, 0·9 mm.; thickness, 0·3 mm.

Remarks and Affinities. The relationship appears to be with the family Alismaceae and the genus *Alisma* but only one carpel has been found at Sandbanks and the determination must be regarded as provisional.

Family HYDROCHARITACEAE

Genus STRATIOTES Linnaeus

Stratiotes hantonensis Chandler

Plate 7, figs. 38–44; Pl. 8, figs. 1–32

1960 *Stratiotes hantonensis* Chandler, pp. 205, 222, pl. 30, figs. 18–25; pl. 33, figs. 87–95.
1961*b* *Stratiotes hantonensis* Chandler: Chandler, p. 105, pl. 24, figs. 12-16.

Description. *Seed*: Suboval in outline usually hooked at the base owing to a projecting knob ('the collar') which carries the micropyle, sometimes also hooked at the apex of the opposite margin giving a sigmoidal outline, frequently much inflated (although often flattened in fossilization). Keel sometimes sharply differentiated from the seed-body, not continued around the base, relatively narrow and rather inconspicuous, merging into the collar or terminating against it. In the sigmoidal seeds the collar is often small, smooth, but conspicuous and prominent. In the hooked seeds it is more often broad, nodular and sometimes obscurely delimited from the seed-body by an inconspicuous constriction. Testa thin but woody, usually ornamented with discontinuous but definite longitudinal ridges and with conspicuous pits of variable size about 0·075 to 0·25 mm. long and 0·03 to 0·05 mm. broad. The superficial appearance varies considerably with the degree of abrasion. Micropyle basal or sub-basal traversing the collar obliquely to the axis of the seed or in a line with it. Hilum variable in position on the dorsal keeled margin, in hooked seeds lying at about one-half to one-third of the length from the base, in sigmoidal seeds at the extremity of the subapical hook or beak. In hooked seeds the raphe is marginal to the apex where it passes directly across the keel to the apical chalaza. In sigmoidal seeds it may once have been marginal but if so has been abraded along the dorsal margin of the keel remaining only as a short transverse canal leading to the chalaza at the apex of the keel. Digitate cells of inner surface of keel elongate parallel with its length, sometimes slightly sinuous. Dimensions of several seeds are respectively: 1) Length, 3 mm.; breadth, 1·75 mm.; thickness, 1·5 mm. 2) Length, 3 mm.; breadth, 2 mm.; thickness, 2·25 mm. 3) Length, 3 mm.; breadth, 2·25 mm.; thickness incomplete. 4) Length, 2·5 mm.; breadth, 1·75 mm.; thickness, 1·25 mm. 5) Length, 3·3 mm.; breadth, 2 mm.; thickness incomplete. 6) Length, 3 mm.; breadth, 1·75 mm.; thickness, 1·25 mm. 7) Length, 4 mm.; breadth, 2·25 mm.; thickness, 1·3 mm.

Remarks and Affinities. One seed only (V.43138) is known from the Freshwater Beds between Middle and Durley Chines, Bournemouth, but in the Bournemouth Marine Series and overlying deposits the species is common up to the top of the Barton Beds where it is virtually superseded by *S. headonensis* Chandler although a few seeds persist into the Lower

Headon (Chandler, 1961*b*). V.36484 from the hard sandy beds of the Bournemouth Marine Series, cliff base, Southbourne, is the holotype (Pl. 7, figs. 38, 39) and there are other unfigured seeds from this site (V.43146). V.43150, V.43153–54 came from a Leafy lenticle in Bournemouth Marine Sands in the same locality. A few seeds were found in soft sands of the Marine Series some seventy to eighty yards east of the East Cliff lift, Bournemouth (V.43142–43) and at Honeycomb Chine, Boscombe (V.43145). From carbonaceous beds associated with the Boscombe Sands at Southbourne there were also numerous examples, (V.43160–61) from broken carbonaceous derived beds at their base and V.43170–76 from lignitic rafts overlying these Sands. The Highcliff Sands at Cliff End, Mudeford, have furnished V.43182–85, V.43187; V.43181 and V.43186 being from the rarely exposed coarse sands in the foreshore revealed by the scouring of 'the Run' for a short time only. All but V.43181 are in addition to figured material. Seeds from the Hengistbury and Barton Beds have been figured and described elsewhere (Chandler, 1960: 205, 222, pl. 30, figs. 18–25; pl. 33, figs. 87–95). The Cliff End seeds are, on the whole, less crushed than the Boscombe and Southbourne specimens so that they appear more inflated and slender. They also have more smoothly rounded contours owing to abrasion during transport in waters charged with fine sand, consequently the surface of the testa is often smoothed and the pits less conspicuous. The sigmoidal form in these abraded seeds tends to be commoner. However, after comparing numerous seeds from the various localities it seems clear that all belong to a single species, no constant specific or even varietal differences can be distinguished and exactly comparable specimens can be found in all. The seeds extracted from the lignitic rafts have evidently undergone prolonged maceration resulting in softening. They were often partially embedded in the sodden woody fragments which formed the bulk of the rafts. Such seeds are somewhat flattened and shapeless yet being protected from surface abrasion their superficial ridges and pits are in many instances peculiarly well preserved.

The species, which has been named *Stratiotes hantonensis*, is clearly distinguished from *S. headonensis* of the overlying topmost Barton and Lower Headon Beds. It is smaller (*S. headonensis* 3·25 to 6·25 mm. long, 2·25 to 4 mm. broad, the larger dimensions the most common), less conspicuously ridged longitudinally, has a narrower less conspicuous keel and is relatively more inflated. In its general characters, rather small size, and course of raphe it bears considerable resemblance to a small seed described as *S. zinndorfi* from beds thought to be of Middle or Upper Oligocene age at Frielensdorf near Cassel (Kirchheimer, 1936: 486; 1937: 290). Later, however, this seed was referred by Menzel to a form of '*Folliculites* [*Stratiotes*] *kaltennordheimensis*' (see Kirchheimer, 1957: 314). The British seeds are appreciably smaller than '*S. zinndorfi*' (3 to 4·5 mm. long, 1·5 to 2 mm. broad), and are beyond doubt clearly distinguished from *Stratiotes kaltennordheimensis* (Zenker) by their shape, considerable smaller size and the course of the raphe canal which divides the keel diagonally in that species and is not marginal and then transverse as in *S. hantonensis*.

Stratiotes minutissimus n. sp.

Plate 7, figs. 29–37

Diagnosis. Seed subovoid to elongate-ovoid, hooked or sigmoidal in outline; keel narrow, inconspicuous; collar large, hollow; testa very thin with fine interrupted longitudinal

ridges, striae and crumples; hilum sub-basal, raphe diagonal sometimes marginal in the lower half of the seed; cells of inner surface of keel with smooth not digitate walls, cells of outer surface of testa slightly sinuous. Length of seed about 1·5 to 2·3 mm.

HOLOTYPE. V. 43130.

DESCRIPTION. *Seed*: Subovoid to elongate-ovoid with large conspicuous asymmetric hollow collar (Pl. 7, figs. 29, 32, 36). Sometimes hooked at the chalazal end as well as at the collar so as to produce a sigmoidal outline (Pl. 7, figs. 29, 37). Keel narrow, only slightly differentiated from the seed-body, not continued round the base but merging into the collar (Pl. 7, figs. 31, 32). Testa very thin, only about 0·016 to 0·025 mm. thick. Surface ornamented with interrupted longitudinal ridges (Pl. 7, figs. 29, 35), also longitudinally striate or crumpled (Pl. 7, figs. 31, 32, 37) owing to the upstanding lateral walls of elongate cells of variable length and about 0·016 mm. in breadth. The walls of these cells, and in consequence the striae or crumples, are very slightly sinuous. External opening of micropyle at the centre of the collar indicated by a small hole towards which the cells converge. It leads into the hollow within the collar which is separated by a constriction from the main cavity of the seed. Hilum marginal, sub-basal, just above the constriction; raphe traversing the keel diagonally to the apical chalaza (Pl. 7, fig. 30) sometimes marginal in the lower half of the seed. Cells of inner surface of keel when exposed by germination with smooth not digitate walls; internal surface of seed-cavity longitudinally crumpled or striate due to the walls of elongate cells about 0·016 to 0·025 mm. broad and of variable length, their ends being square or bevelled. Structure of tegmen obscure. Dimensions of seeds: 1) Length, 1·5 mm.; breadth, 0·75 mm. 2) Length, 2·2 mm.; breadth, 0·75 mm. 3) Length, 2·1 mm.; breadth, 0·8 mm. 4) Length, 2 mm.; breadth, 0·5 mm. 5) Length, 2·3 mm.; breadth, 0·75 mm.

REMARKS AND AFFINITIES. Sixteen seeds from the Bournemouth Freshwater Beds at Sandbanks, Dorset (V.43136–37 unfigured). Some are perfect, others represented by one valve only. On drying, owing to their thinness, they tend to burst longitudinally. The form and arrangement of the organs leave no doubt as to the generic identity but the species is sharply distinguished from any other hitherto described by its unusually small size, thin testa, absence of coarse external pits, large micropylar cavity within the collar and straight-walled cells on the inner surface of the keel. In the fruits of living *Stratiotes* a few abortive and stunted seeds may be present, and in species from the Hamstead Beds small, obviously immature and abortive seeds are associated with numerous well developed large specimens. The Sandbanks seeds although so small and thin walled are probably mature for all are of the same type. Had larger seeds been present they would certainly have been preserved on account of their more resistant testas. This small primitive species has been named *S. minutissimus*. There appears to have been a progressive increase in size within the genus in passing upwards to Oligocene strata. Thus *S. hantonensis* which is larger than *S. minutissimus* occurs rarely in the higher beds of the Bournemouth Freshwater Series and abundantly in succeeding beds (see p. 62). *S. headonensis* from the highest Barton Beds to the Upper Headon is still larger and the Oligocene species exceed any from the Eocene in size.

Family CYPERACEAE

Section SCIRPOIDEAE

Genus SCIRPUS (Tourn.) L.

Scirpus lakensis Chandler

Plate 8, figs. 33–41

1960 *Scirpus lakensis* Chandler, p. 206, pl. 30, fig. 26.
1961*a* *Scirpus lakensis* Chandler: Chandler, p. 33.
1962 *Scirpus lakensis* Chandler: Chandler, p. 50, pl. 6, figs. 7-18.

The species was fully described by Chandler (1962). The description there given applies equally to the material from the Bournemouth Freshwater Beds. At this horizon the carbonaceous outer coat is always abraded in the specimens so far seen and the stiff bristles representing broken down cell walls are a most conspicuous feature (Pl. 8, figs. 34, 35, 38). They often obscure the whole surface including the basal neck. The texture of bristles and inner translucent coat, when exposed by abrasion is chitinous, shining and tough. Like specimens from Swanwick, Hampshire (Chandler, 1962, pl. 6, figs. 16-18), some of the Sandbanks fruits show an inner semitranslucent oval seed which does not extend into the neck, but, on maceration, displays a patch of thickening at base and apex suggesting terminal organs of the erect anatropous seed. Most fruits, however, are mere empty husks with no seed preserved, as shown by maceration. In the Lower Bagshot the species was largely confined to the fine silt-like sediments at the base of the section at Lake. At Sandbanks it was abundant in fine, well-bedded silts below Simpson's Folly (Pl. 8, figs. 33–36 and V.43190–92) and in similar silts between Simpson's Folly and Shore Road (V.43200–01) in both of which it was associated with abundant cuticle fragments. These occurrences suggest a gregarious water plant growing in quiet lagoons or backwaters not disturbed by main river currents. It was found also at Sandbanks in the coarse sand from which most of the plants were obtained. At Branksome Dene it was fairly common (Pl. 8, figs. 37, 38 and V.43195–98) and there is one record from beds nearer Bournemouth between Durley and Middle Chines (Pl. 8, fig. 39). One or two fruits from Sandbanks are referred doubtfully to this species on account of their greater size (length, 2 to 2·25 mm. incomplete; breadth, 1·25 mm).

In the Bracklesham Beds at Alum Bay, Isle of Wight, which may perhaps correspond in age with the Bournemouth Freshwater Series, two much battered fruits have been found (Pl. 8, figs. 40, 41) but up to the present there are no records from the Bournemouth Marine Beds although a fruit is known from Hengistbury (Chandler, 1960: 206, pl. 30, fig. 26). An incomplete fruit was recorded from Cuisian Beds at East Wittering, Sussex (Chandler, 1961*a*: 33).

Section CARICOIDEAE

Genus CARICOIDEA Chandler, 1957:86

Caricoidea obscura Chandler

Plate 8, figs. 42–56

1960 *Caricoidea obscura* Chandler, pp.207, 223, pl. 30, figs. 27–33; pl. 33, figs. 98–105.
1961*a* *Caricoidea obscura* Chandler: Chandler, p. 33, pl. 7, fig. 34.

1961*b* *Caricoidea obscura* Chandler: Chandler, p. 106, pl. 24, figs. 22–24.
1962 *Caricoidea obscura* Chandler: Chandler, p. 52, pl. 6, figs. 20–33; text-fig. 9.

Fruits and endocarps, sometimes enclosing seeds, were described by Chandler in the above references. There is little to add to the published accounts except that some slightly greater variations in the sizes of the fruits and their cell structure have been noted. Specimens are now known from older and younger horizons. The holotype comes from the Highcliff Sands, Cliff End, near Mudeford. Fruits from the Bournemouth Freshwater Beds at Sandbanks are about 1·9 mm. long and 1·5 mm. broad. The spongy exocarp is 0·5 to 0·6 mm. thick near the base, 0·15 mm. near the apex and the equiaxial cells which form this coat are 0·008 to 0·016 mm. in diameter where measured. The endocarp is 1 mm. long, 0·75 mm. broad, 0·1 mm. thick and is longitudinally striate internally, the striae being about 0·007 mm. apart. This horizon yielded three specimens (Pl. 8, figs. 42–44), a limited number of fruits were collected in the Bournemouth Marine Beds (Pl. 8, figs. 45, 51) and in Lignites above the Boscombe Sands at Southbourne (Pl. 8, fig. 46). In the Highcliff Sands it appears to have been abundant and over twenty specimens were collected but some have since decayed (Pl. 8, figs. 47–50 and V.43210–14). The dimensions from this type locality are: length of fruit, 1·1 to 1·6 mm., examples of breadth are 1·1 by 1·4 and 1 by 1·5 mm. Length of endocarp, 0·95 to 1·1 mm.; breadth, 0·6 to 0·8 mm. Seeds are represented by remains of hyaline testa in the locule formed of transversely aligned cells producing striae 0·012 to 0·016 mm. apart. There are also specimens doubtfully referred to the species from Southbourne below the Boscombe Sands (Pl. 8, fig. 52) and from Cliff End (Pl. 8, figs. 53, 54) having an unusual subglobose form and narrowed rather abruptly to the base so that the neck is clearly delimited. A pair of obscure longitudinal ridges was also noted giving a slight bisymmetry while the surface cells are rather coarser than in the more typical specimens. Two other fruits are similar but larger (Pl. 8, figs. 55, 56). However these slight differences are probably individual rather than of specific significance. In fossilization there was a marked tendency for fruit and endocarp to separate very readily and in most instances, when separated, the surface of the endocarp was very smooth. Lake, Hengistbury, Barton and Hordle have all yielded material.

The single-seeded fruits with spongy exocarp adapted for floating and hard endocarp with large basal foramen indicate the section Caricoideae of the family Cyperaceae. Endocarps of the type seen are not uncommon in living genera but few have correspondingly thick spongy enveloping exocarp. The nearest resemblance is found in *Mapania* but here the fruits are rounded above and do not show the longitudinal angles and flattening probably caused by pressure of other fruits in growth so that a different type of inflorescence may be indicated. The fossils named *Caricoidea obscura* are moreover much smaller than any species of *Mapania* seen and lack three conspicuous longitudinal fibres associated with the exocarp in that genus, although possibly these could have been removed by abrasion in the majority of fossils examined.

Caricoidea angulata n. sp.

Plate 9, figs. 1–23; Text-fig. 12

Diagnosis. Fruits growing in a close thick spike, one-loculed, one-seeded. Form of fruits variable, often faceted. Style prominent apical, base slightly truncate. Exocarp thick and

spongy, thickest at the apex. Length of fruit about 2 to 2·6 mm.; breadth about 1·4 to 2 mm. Endocarp obovoid or oburceolate, apiculate at apex with basal aperture, without external longitudinal ridges. Length of endocarp, 1·1 to 2 mm.; breadth, 1·1 to 1·5 mm.

HOLOTYPE. V.43218.

DESCRIPTION. *Fruit*: One-loculed, one-seeded, frequently longitudinally faceted indicating that they grew in a close spike, a deduction confirmed by the finding of specimens still adhering in the position of growth (Pl. 9, fig. 2; cf. Text-fig. 12), evidently crowded in the

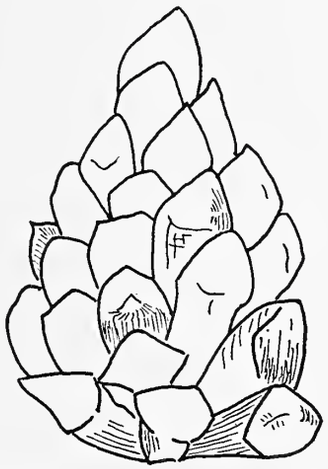


Fig. 12. *Caricoidea angulata* n.sp. Diagram to show mode of growth as deduced from fruits still adherent as in life.

head as suggested by considerable differences of size and shape (cf. Pl. 9, figs. 1, 4–6, 16, 17). Normally sub-obovoid. One fruit has two or three facets on the inner face (towards axis of spike) but is rounded on the outer face, the facets extending for from half the length to almost the whole length of the fruit. Another fruit is three-angled. Apex when best preserved usually pointed with apical style (Pl. 9, figs. 3, 5) but more frequently the style is abraded although clearly apical. Base slightly truncate pierced by a large foramen (Pl. 9, figs. 5, 13–15). Epicarp frequently abraded, when preserved black, formed of longitudinally aligned cells with finely sinuous or digitate walls. These cells vary in size in different parts of the surface, near the base they are oblong forming longitudinal striations 0·016 to 0·025 mm. apart. Exocarp within formed of spongy parenchyma, its cells varying in size from about 0·01 to 0·025 mm. in diameter, and the tissue varying in thickness in different parts of the fruit, thinnest beneath the facets, thickest at the apex. Length of fruit, 2 to 2·6 mm.; breadth about 1·4 to 2 mm.; thickness about 1·75 mm.

Endocarp: (Pl. 9, figs. 8–10, 15, 19–21) obovoid or oburceolate, apiculate at the terminal stylar end, sometimes conspicuously narrowed to the truncate base which is pierced by a large circular foramen (Pl. 9, figs. 8–10, 18) which may be closed by a hilar plug. Wall formed of fine close-textured parenchyma, with cells about 0·016 mm. in diameter, giving a smooth finely-granular surface without external longitudinal ribs (Pl. 9, figs. 8, 9). Locule with obscure longitudinal ridges about 0·05 mm. apart. Dimensions of typical endocarps are: 1·3 by 1·3mm.;

1·8 by 1·25 mm.; 1·5 by 1·25 mm.; 1·1 by 1·1 mm. The longest endocarp measured was 2 mm.; and the broadest, 1·5 mm.

Remarks and Affinities. Numerous fruits and some detached endocarps (V.43228–34) from the Bournemouth Freshwater Beds at Sandbanks and from Branksome Dene (V.43235, V43237-38). There are also figured and unfigured (V.43244) specimens from successive horizons in the Bournemouth Marine Beds and Boscombe Sands. Some immature or abortive specimens (V.43241, V.43245) are from the Leafy lenticle in Marine Beds, cliff base, Southbourne. The species is larger and usually more fusiform and angled or faceted than *Caricoidea obscura* and its base is only slightly truncate while its exocarp is, unlike *C. obscura*, thickest at the apex, but its characters and the basal foramen of the endocarp indicate the section Caricoideae. It has not yet been found in the Highcliff Sands or younger beds. As in the case of *C. obscura* the most comparable living genus is *Mapania* with its thick spongy exocarp, hard compact endocarp with basal foramen and obscurely longitudinally ridged locule surface. The superficial resemblance to *Cladium* may be noted but *Cladium* lacks the thick compact spongy exocarp and its endocarp has marked external longitudinal ribs. It somewhat resembles *Diplasia* in the arrangement of the spongy coat but the fruits of *Diplasia* grow in a close slender spike.

Caricoidea sp.

Plate 9, fig. 24

A small endocarp (V.43248) without the surrounding fruit. It has a conspicuous basal neck closed by a plug, a scarcely perceptible mucro and globular body. The surface is conspicuously and coarsely pitted, the pits varying in diameter from 0·05 to 0·15 mm. Wall formed of spongy tissue, its cells about 0·01 mm. in diameter. Length including neck, 1 mm.; breadth, 0·75 mm. From the Lignite above the Boscombe Sands, Southbourne.

Genus SCLERIOCARYA nov.

Diagnosis. Fruits belonging to Cyperaceae, resembling *Scleria* in having three large bracts united at the base but differing in varying details from any living species seen.

Type Species. *Scleriocarya tribrachteata* n. sp.

Scleriocarya tribrachteata n. sp.

Plate 9, figs. 25–27

Diagnosis. That of the genus.

Holotype. V.43249.

Description. *Fruit*: Partly enclosed in three large thick bracts united below, free above. Bracts having contiguous lateral margins and rounded apices; they are almost as long as the fruit and are somewhat crumpled superficially; in cross section they are lunate, formed of fine uniform parenchyma, cells being about 0·02 mm. in diameter; each bract is pierced by a median longitudinal canal just beneath the external surface, possibly connected with a midrib. Fruit itself within the bracts subovoid but roundly trigonous slightly trilobed as viewed from base or apex with small stylar apiculation and six obscure longitudinal angles or ridges

extending from the base almost to the equator. Three ridges lie along the rounded lobes and three on intermediate but slightly convex surfaces between them. Base with large foramen, 0·4 mm. in diameter externally, 0·2 mm. internally, closed by a plug which forms the placenta from the margin of which the bracts arise. There is a tendency for longitudinal splitting to occur at the apex along the middle of the lobes. Length, 2 mm.; breadth with one bract still adhering, 2 mm.

Remarks and Affinities. When first seen the fruit showed the three adherent bracts but two quickly became detached. The relationship to Cyperaceae is clear, the nearest living genus seen being *Scleria* Berg, in which three distinct bracts arise from the margin of a basal disc. No species yet seen shows all the characters of the fossil. *S. sumatrensis* has a much smaller fruit but equally large and more foliose bracts. The form and surface of the fruit itself are quite unlike those of the fossil. *S. vogelii* has thick fleshy bracts but the fruit itself is smooth and globular. *S. lithospermum* has a smooth triangular fruit with basal ridges. Thus various of the characters described are distributed in the living genus *Scleria* but not apparently in a single species. Accordingly the fossil has been distinguished as *Scleriocarya tribracteata*. *Scleria* itself occurs in sub-tropical and tropical regions. There is a single species in Atlantic North America. One fruit only (V.43249) from coarse dark sands exposed in the foreshore at Cliff End, near Mudeford by the scouring of 'the Run' (see p. 18).

Genus CLADIOCARYA Reid & Chandler, 1926:77

Cladiocarya foveolata Reid & Chandler

Plate 9, figs. 28, 29

1926 *Cladiocarya foveolata* Reid & Chandler, p. 77, pl. 4, figs. 22, 23.

Description. *Endocarp*: Oburceolate, bisymmetric, tapering at the apex where there is a large mucro compressed at right angles to the plane of symmetry. Base with short truncate neck and large terminal aperture. Two longitudinal ridges, one on each side, lie in the plane of symmetry and are continuous from base to apex. Surface ornamented with a few large conspicuous unequal depressions aligned approximately in longitudinal rows; some of the depressions are longitudinally elongate, others are equiaxial. Length including neck and style, 1·3 mm.; greatest diameter, 0·75 mm.

Remarks and Affinities. One endocarp (V.43250) from the Highcliff Sands, Cliff End, Mudeford. It is very similar to *Cladiocarya foveolata* Reid & Chandler from the Bembridge Beds and is referred to that species in spite of the greater irregularity of its large superficial depressions and its somewhat less conspicuous lateral ridges. Fuller knowledge of the family Cyperaceae than was available in 1926 points to relationship with the section Caricoideae. Similar oburceolate endocarps occur in *Cladium* and *Chorisandra*. However, in these two genera endocarps are not bisymmetric while in *Cladium* the surface is smooth and in *Chorisandra* the longitudinal rows of pits show a greater regularity of arrangement. There are many genera of the Caricoideae which could not be examined and it does not seem possible at present to refer this fossil to a living genus yet it appears to be more clearly defined than the form-genus *Caricoidea*.

Family PALMAE

Section LEPIDOCARYINAE

Sub-section CALAMEAE

Genus CALAMUS Linnaeus

Calamus daemonorops (Unger)

Plate 9, figs. 30–34

1860 *Palaeospathe Daemonorops* Unger, p. 9, pl. 2, figs. 9–12.
1862 *Palmacites Daemonorops* (Unger) Heer, p. 1056, pl. 55, figs. 7–15; pl. 60, figs. 50–53; pl. 62.
1957 *Calamus daemonorops* (Unger) Chandler, p. 88, pl. 12, figs. 24–42.
1962 *Calamus daemonorops* (Unger) Chandler, p. 55, pl. 7, fig. 6.

Three spine bases were found in the Freshwater Beds of Branksome Dene. They are of irregular shape with rough surfaces upon which black, shining, tapering, stiff spines are borne. The actual spines are always broken at the distal end. One specimen (V.43251) shows a single spine, another bears two spine bases (V.43252) and the third three (V.43253) of which one is bent and distorted. The surface of the spine bases is too sand-pitted for the cell structure to be preserved. The spines are longitudinally striate, the striations being due to small rectangular cells. Largest base preserved, 6·25 by 4 mm. in diameter. Longest specimen from base to broken tip of spine, 7·5 mm.

They agree with material from Bovey Tracey and from the Dorset Pipe-clay Series at Lake indicating a long range in time for the species. At Bovey it is also represented by a number of different plant organs which confirm the reference of the spines to *Calamus* (Chandler, 1957: 89). Gardner (1882: 7) recorded a large palm stem and numerous spines (illustrated attached to a piece of bark in Gardner's unpublished portfolio in the British Museum (Natural History)) in the strata west of 'Watering Chine or Branksome Glen' (= Branksome Chine). Spines also occurred in his 'Coastguard Beds' west of the Bourne Valley (Gardner & Ettingshausen, 1879: 17, 18) abundantly in the Marine Beds near the junction with the Freshwater Beds and about 120 yards east of Honeycomb Chine. Carruthers identified them, we now know erroneously, as Cactus (Gardner, 1879: 220, 224, footnote on p. 220). A much battered spine base with short broken remains only of several spines was found in the Highcliff Sands (V.43254). This specimen and a single very small spine from the same locality (V.43255) are not sufficiently well preserved for certain determination.

Genus PALMOSPERMUM Reid & Chandler, 1933: 110

Palmospermum sp.

Plate 9, figs. 35, 36; Text-fig. 13

A much compressed seed from the Lignite above the Boscombe Sands, Southbourne, appears to be referable to Palmae. It has been crushed obliquely and is therefore difficult to interpret. It appears to have a large, spathulate, slightly convex scar, now situated obliquely on one face, which may represent the hilar chalazal scar. Hilum and embryo scar are not clear

and parts of the surface are obscured by adherent fragments of lignite. The whole surface is ornamented by a network of elongate meshes due to shallow furrows which diverge from the spathulate scar. These furrows enclose slightly convex areas between them and almost cer-

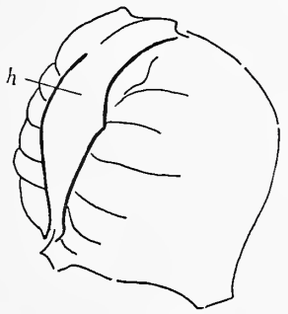


Fig. 13. *Palmospermum* sp. Crushed seed, side, showing hilar-chalazal scar, *h*, to elucidate Pl. 9, fig. 35.

tainly indicate ruminations of the albumen, as seen in many palm seeds. The testa is columnar as seen in section on a fractured surface, about 0·05 to 0·15 mm. thick. Testa superficially pitted, the fine cells being about 0·012 mm. in diameter. The diameter of the crushed seed is 3·5 mm. In the absence of further fossil material, and having regard to the poor preservation of the one specimen known, it has not been possible to relate this seed to a living genus. It is of the type of *Oncosperma* but much smaller.

Section CORYPHEAE

Genus SABAL Adanson

Sabal sp.

Plate 10, figs. 8–15

DESCRIPTION. Fragmentary and much battered remains of fan-like palm leaves are frequent among the matted lignitic remains above the Boscombe Sands, Southbourne. Similar remains were mentioned by Ord (1914: 124, pl. 17, fig. 1) as abundant in the Marine Beds near the cliff base 200 yards east of the East Cliff lift in a lignitic bluff now destroyed.

No fragment so far seen shows more than a few broken inner ends of pinnae, a short length of rachis, and much worn remains of a short triangular ligule with rounded upstanding margins. The rachis (as preserved) is triangular at the base on the lower surface, it gradually contracts above and sinks below the general surface of the blade. On the upper surface it is much less conspicuous and obscured by confused remains of the ligule. One rounded petiole fragment twisted onto a leaf may or may not belong to the species. The pinnae which are united at the centre of the leaf are arranged so that the grooves between them are deeper and more conspicuous on the lower than on the upper surface. As seen on the lower surface the upper pinnae overlap the lower while on the upper surface the opposite is of course seen. Longest fragment about 1·3 mm. Others were about 9 to 9·6 mm. About seventeen fragments were found

but they were in a perished condition and have now decayed. The character of the ligule and rachis points to alliance with *Sabal*. The leaves must have been small. They recall a fragment of a fan palm from the Lower Bagshot of Arne, Dorset (Chandler, 1962: 56, pl. 7, figs. 7, 8).

In the Geological Survey Museum there is a fragment of fan palm (3029) from the East Cliff, Bournemouth, in a brownish matrix. Another specimen of doubtful origin is in the British Museum (Natural History) (38759) labelled Middle Eocene and doubtfully ascribed to Bournemouth or the Lower Bagshot of Surrey. The latter alternative appears to be very unlikely.

Genera?

Text-figs. 1–4 (see pp. 5-8)

The illustrations of pinnate palm leaves and of a fruiting axis are all taken from drawings or lithographs in the Gardner portfolio in the British Museum (Natural History). The most important of the specimens shown (Text-fig. 1; V.16850) represents the distal end of a leaf on a block measuring four by three feet. Some pinnules are opposite, others alternate. The occurrence of this and other palms is described by Gardner (1878: 47, 369) and Gardner & Ettingshausen (1879: 17) in compact dark clay in the near neighbourhood of Bournemouth west of the pier under the Highcliff Mansions. Elsewhere it has been suggested that the leaf may have been a *Nipa* (British Museum Guide to Fossil Plants, 1935: 61) but there does not appear to be sufficient evidence to decide the relationship.

In the leaf fragment shown in Text-fig. 2 (V.486) the pinnules appear to be shorter and broader than those in Fig. 1. The original lithograph is natural size.

Text-fig. 3 shows a fragment, V.44296, one of two counterparts illustrated in the portfolio in which the pinnules appear to shred longitudinally throughout their length. As the matrix is light in colour and comparable with that in which the impressions of *Gleichenia* are preserved it appears almost certain that these fragments are from lower layers at the same spot. If so they are no doubt the leaves stated by Gardner & Ettingshausen (1879: 17) 'to resemble *Iriartea* more than any other genus'. These leaves are rarely met with elsewhere (Gardner, 1882: 8). The original lithograph is natural size.

The fruiting stalks in Text-fig. 4 were believed to be those of a date palm (Gardner, 1882: 8, footnote). The lithograph is natural size with a small portion showing two fruitlets magnified about four times. The manuscript in the Gardner portfolio states that they were found between Great Durley Chine and the Bourne Valley.

Family NIPACEAE

Genus NIPA Thunberg

Nipa burtini (Brongniart) Ettingshausen

Plate 10, figs. 1–7

1879 *Nipadites crassus* Bowerbank: Gardner, p. 221.
1894 *Nipadites burtini* (Brongniart): Rendle, p. 147.
1917 *Nipadites* (*N. parkinsoni*?) (Brongniart): White, pp. 31, 32, 34.

1933 *Nipa burtini* (Brongniart): Reid & Chandler, p. 118, pl. 2, figs. 1–6. See also for earlier references.
1961 *Nipa burtini* (Brongniart): Chandler, p. 133, pl. 14, figs. 4–9.
1961*a* *Nipa burtini* (Brongniart): Chandler, p. 33, pl. 9, fig. 49; pl. 10, figs. 51–53.

DESCRIPTION. *Fruit*: As described for *N. burtini*, varying much in size and shape, preserved as scarcely indurated sandy casts with a covering film only of decayed carbonaceous substance. Base usually abraded but illustrated by Gardner in his unpublished portfolio. Apex three- to five-angled also somewhat abraded so that the umbo is rarely preserved. Epicarp decayed. Sarcocarp smooth except for the clear impressions of the characteristic coarse longitudinal fibres. Endocarp, seen only on a few decaying carbonaceous fragments, having a mass of fine parenchymatous tissue within and transverse matted fibres outside. Longest specimen as illustrated by Gardner in an unpublished lithographed plate in the Gardner portfolio (B.M. (N.H.)) about 71 mm. and 55 mm. broad. Another Gardner specimen is 67 by 45 mm., one side having two facets and the opposite being flat. One small perfect Gardner specimen is 43 by 25 mm. The largest specimen found recently is 56 mm. broad, length imperfect.

Seed: Also variable in size and form, inflated or compressed, sometimes longitudinally angled or obscurely longitudinally furrowed. Testa decayed, the internal cast showing obscure impressions of a meshwork of ridges (furrows in the cast). Three seeds measured as follows: 1) Length, 45 mm.; breadth (imperfect), 40 mm. 2) Length, 40 mm.; breadth, 34 mm. 3) Length, 34 mm.; breadth, 40 mm.

REMARKS. The mode of preservation of these fruits makes them difficult to extract whole and to preserve permanently. They are very abundant in the soft crumbling sands of Honeycomb Chine, Boscombe. Casts of seeds with or without remains of fruits are as common as those of the fruits. After rain has washed the cliff surface the casts project conspicuously, the softer matrix around them being more readily washed away. Specimens are said to have occurred also west of Boscombe Chine but sparingly (Gardner, 1879: 222). Gardner's lithograph shows seven fruits but none of these appears to have survived. In addition to the fruits and seeds here figured from recent collections there are a number of others still preserved (V.14916, V.43079–V.43100). An imperfect seed cast (V.43082) shows the testa corrugations obscurely as impressions. V.43081 shows the lower half of a fruit incomplete on one side with seed enclosed. V.15858 is a fine fruit apex with projecting seed cast.

The specimens cannot be separated from *N. burtini* of the London Clay.

Class *DICOTYLEDONES*

Family BETULACEAE

Genus CARPINUS Linnaeus

Carpinus boveyanus (Heer)

Plate 10, figs. 16–20

1862 *Carpolithus boveyanus* Heer, p. 1077, pl. 70, figs. 7–14 (in part).
1957 *Carpinus boveyanus* (Heer) pars Chandler, p. 92, pl. 13, figs. 52–67.
1961*b* *Carpinus boveyanus* (Heer): Chandler, p. 110, pl. 25, fig. 35.

DESCRIPTION. *Fruit*: Broadly ovate or roundly triangular in outline, originally somewhat flattened subovoid but much compressed in fossilization, bisymmetric. Scar of attachment to bract (no longer preserved) subcircular, basal, 1 to 1·2 mm. in maximum breadth. Calyx accrescent almost entirely covering the fruit, having a few simple longitudinal vascular strands which arise at the margin of the basal scar. Five such strands are visible on one surface of a fruit from the Highcliff Sands, Cliff End, near Mudeford (V.43260). Surface of calyx smooth formed of equiaxial or oblong cells about 0·008 mm. in diameter, their arrangement in longitudinal rows producing a striate effect. Near the apex in one or two fruits where abrasion had occurred there is evidence of underlying coarser equiaxial cells about 0·016 mm. in diameter. Again over the middle of another fruit where the calyx is broken or worn away there are equiaxial cells 0·012 mm. in diameter and longitudinal striations. Length and breadth of some fruits 1) from Southbourne: 2·25 by 2·25 mm.; 3 by 2 mm.; 3·1 by 2·1 mm.; 3·25 by 2·5 mm.; 3 by 1·9 mm. 2) from the Highcliff Sands, Cliff End, near Mudeford: 3·3 by 2·25 mm.; 3 by 2·7 mm.

Endocarp: Agreeing with the fruit in shape, one-loculed, with apical style, dehiscing into equal valves along a broad marginal suture (Pl. 10, fig. 20). Wall woody, fine-textured, hard (surface much abraded), formed of equiaxial cells. Locule compressed, urceolate in longitudinal section, tapering to the narrow stylar canal. Locule surface much corroded but showing obscurely equiaxial cells about 0·025 mm. in diameter. Dimensions approximating to those of the fruits.

Seed: Seen in a broken specimen (V.43260) much shrivelled but with testa of equiaxial cells about 0·016 mm. in diameter with a tendency (increased by shrinkage) to be arranged in longitudinal rows.

REMARKS. A much compressed specimen (V.43257) from a Leafy lenticle in the Marine Beds at the base of the cliff, Southbourne. Three more elongate triangular fruits (V.43258) two being unfigured specimens (V.43259) are from the Lignite above the Boscombe Sands, Southbourne, and two (V.43260–61) from the Highcliff Sands, Cliff End, Mudeford. One doubtful impression represented by counterparts (V.43262) comes from the Freshwater Beds, Durley Chine, Bournemouth. The structure indicates *Carpinus*. Specimens were compared microscopically with material from Bovey Tracey which they closely resemble in size and appearance as well as in detailed structure so far as the crushed material available could show. The Southbourne and Bovey fruits are therefore regarded as belonging to a single species. Among the living *Carpinus* species small fruited forms like *C. laxifolia* (China and Japan) most nearly resemble the fossil.

Genus ALNUS (Tourn.) L.

Alnus poolensis n. sp.

Plate 10, figs. 21, 22; Pl. 11, figs. 1–8

DIAGNOSIS. Cones and fruits small in comparison with most living species. Fruits oval to pentangular about 1·4 mm. long (excluding styles), 0·8 to 1·05 mm. broad, wings, 0·1 mm. or less in breadth.

HOLOTYPE. V.43263.

DESCRIPTION. *Cone*: With woody pedicel 2·5 mm. long and 1·4 mm. broad at its base in one specimen (V.43263), 7 mm. long and 1·5 mm. broad in a second imperfect cone provisionally regarded as belonging to the same species represented only by the basal part embedded in matrix (V.43268). Scales woody, persistent, peltate, expanded at the distal end into a thick broad dorsiventrally compressed nodular escutcheon which is slightly four-lobed on the upper surface and provided with a subterminal triangular umbo on the lower surface. The lower surface of the scales in V.43268 has several marked longitudinal ridges represented by furrows on its impressions, the upper surface has not been seen in this specimen and the umbo is obscure owing to poor preservation. Length of V.43263 incomplete, only about 5 mm. being preserved (excluding pedicel); breadth (compressed), 4·4 mm.; length of stalk of one scale, 1·5 mm. on upper surface, 1 mm. on lower surface; greatest breadth of the peltate head of a scale, 2 mm.; least breadth, 0·8 mm.; greatest breadth of triangular umbo, 1 mm.; least breadth, 0·7 mm. Length of V.43502 an unfigured small distorted but perfect cone, 5 mm. (including stalk 1·5 mm.); breadth, 4 mm. Length of V.43268 preserved, 8 mm.; estimated breadth, double that of the perfect half, 8 mm.; maximum breadth at tip of scale from this cone, 3 mm.; length from axis to tip, 4 mm.

Fruit: Two-loculed, flat, varying in outline from oval with truncate base to subpentagonal, two styles, patent, about 0·1 mm. long, wings thick about 0·1 mm. or less in breadth, usually delimited from the body of the fruit by a slight longitudinal ridge; surface smooth, finely striate longitudinally, striae from 0·009 to 0·01 mm. apart. Dimensions of four fruits, length without styles in each case, as follows: 1) 1·5 by 1·05 mm. 2) 1·4 by 0·96 mm. 3) 1·4 by 0·8 mm. 4) 1·4 by 0·9 mm.

REMARKS AND AFFINITIES. A figured cone and its detached scales, an unfigured perfect but small cone (V.43502), a cone axis with scale bases and a few figured and unfigured fruits (V.43503) came from Sandbanks. There is a single fruit from Branksome Dene (V.43267) and the basal part of a figured cone from an unspecified horizon in the Freshwater Beds (V.43268). Owing to poor preservation and absence of fruits in V.43268 its characters are not fully known and the specimen is referred provisionally only to this species. When perfect it must have been considerably larger than the Sandbanks material.

The long stalked cones with thin flat scales, the four-lobed apices and the two-loculed fruits all indicate Betulaceae while the persistent entire scales and thick wings of the fruit point to *Alnus* and distinguish the fossils from *Betula*. Cones and fruits are presumed to belong to the same species, possibly even to the same specimen as they were closely associated in a very small exposure. Carbonaceous fossils commonly shrink on drying which may explain the exceptionally small size noted as compared with most living species. The larger V.43268 may have been prevented from shrinking by the matrix in which it was embedded. One of the smallest fruited living species available for comparison was *Alnus rhombifolia* in which some specimens comparable in size with the fossil were seen.

Family MORACEAE

Genus MORUS (Tourn.) L.

Morus poolensis n. sp.

Plate 11, figs. 9–12

DIAGNOSIS. Endocarp subcircular in outline; interlocking cells of the locule lining subcircular, only 0·037 to 0·05 mm. in diameter. Diameter of endocarp about 2·2 mm.

HOLOTYPE. V. 43269.

DESCRIPTION. *Endocarp*: One-loculed, bisymmetric, woody, subcircular in outline, laterally compressed, splitting in the plane of symmetry into equal valves, remains of the funicle represented by a short woody process parallel with the margin which arises from the marginal subapical placenta. External surface finely granular, formed in part of irregular polygonal cells about 0·025 mm. in diameter; carpel wall 0·05 to 0·1 mm. thick, thickest near the placenta, as seen in section, formed of two or more layers of radially directed cells about 0·05 mm. deep, 0·025 mm. broad. Surface of locule formed by a layer of large interlocking subcircular cells about 0·037 to 0·05 mm. in diameter. Length of endocarp, 2·2 mm.; breadth, 2·2 mm.

Seed: Solitary, pendulous, conforming to the locule in shape, anatropous, micropyle and hilum adjacent, marginal, lying immediately beneath the placenta, chalaza (?) at the opposite end indicated by a corresponding depression in the locule wall, raphe probably marginal, ventral as indicated by a similar long narrow groove in the locule. Testa striate in part, the striations diverging from the micropyle, formed of equiaxial cells about 0·016 to 0·025 mm. in diameter directed towards the hilar micropylar end to form the striations described.

REMARKS AND AFFINITIES. Two endocarps, both imperfect, from Sandbanks. One is represented by a single valve complete at the placenta, broken at the opposite end; it shows the micropylar end of a seed. The other is an incomplete valve in two pieces showing less full evidence of the placental end but perfect at the opposite end.

The relationship is unquestionably with *Morus* as indicated by every detail of structure. It differs clearly from *M. nigra* in its more circular outline (*M. nigra* is oval) and in the smaller size of the interlocking cells of the locule lining (*M. nigra* cells 0·1 mm. in diameter). A typical endocarp of *M. nigra* measured 3·5 by 2·5 mm.

Genus FICUS Linnaeus

Ficus lucidus Chandler

Plate 11, figs. 13–15

1962 *Ficus lucidus* Chandler, p. 58, pl. 7, figs. 13–18; text-fig. 11.

Eight endocarps identical in character with those from Lake, the description given in 1962 being equally applicable to the Bournemouth Freshwater specimens although these have undergone more crushing and distortion. The range of size (length, 1·4 to 1·85 mm.; breadth, 0·95 to 1·2 mm.) is comparable.

In addition to the figured specimens from Sandbanks and Branksome Dene there are three others (V.43499) from Sandbanks and two (V.43500) from Branksome Dene.

Genus BECKTONIA Chandler, 1961*b*: 113

Becktonia hantonensis Chandler

Plate 11, figs. 16–22

1961*b* *Becktonia hantonensis* Chandler, p. 113, pl. 25, fig. 39.

DESCRIPTION. *Endocarp*: Sub-ovoid but rounded triangular at the apex the angles dying out at about one-third of the length from the base and one angle sometimes sharper than the other two. Surfaces between the angles more or less flat with a tendency to be slightly concave above and convex below especially in a specimen from Sandbanks (V.43275). This also has subsidiary rounded ridges below which die out above the middle. Surface ornamented with low irregular rugosities formed of equiaxial cells. Foramen for the funicle apical slightly asymmetric and oblique, conspicuous on one of the broad surfaces in the sharper angle, placenta immediately within the foramen. Surface cells equiaxial (seen in one Sandbanks specimen). Walls woody, compacted and vitreous in section, seen in V.43274, so that the cell structure is obscure but two regions are distinguishable, an outer about 0·2 mm. thick and an inner about 0·03 mm. In one Sandbanks specimen the wall appears columnar in section the straight columns about 0·01 mm. in diameter made of several cells end to end. Locule lining of rounded or angular cells with interlocking digitate walls. Rectangular cells, longitudinally aligned, producing longitudinal striations also seen on the surface of the locule probably representing adherent testa, or impressions of testa cells. Length of V.43274, 3·3 mm.; breadth, 2·4 by 2·7 mm. Length of one endocarp from Sandbanks, 3·5 mm.; breadth, 2·75 mm. and of another (crushed and flattened), 4·25 mm.; breadth, 2 mm.

Seed: Anatropous, pendulous, hilum contiguous with the apical placenta, testa thin, formed of several layers one of which (the middle layer?) shows angular cells about 0·02 mm. in diameter aligned in longitudinal rows. There are also remains of a layer of equiaxial cells about 0·016 to 0·025 mm. in diameter. A coat of irregular much inflated cells appears to form the external surface and in one Sandbanks specimen thin-walled cells with markedly sinuous outlines can be seen, diameter about 0·05 mm.

REMARKS AND AFFINITIES. Three endocarps from the Freshwater Beds. V.43274 was broken to show the seed and its attachment. The single-seeded locule, hard endocarp, digitate cells of the locule lining, oblique funicular aperture and pendulous anatropous seed indicate relationship with Moraceae. The first described specimen (Chandler, 1961*b*: 113) was named *Becktonia* from the locality near Beckton Bunny in Hordle cliffs where it was found.

Genus?

Plate 11, figs. 23–27; Text-fig. 14

DESCRIPTION. *Endocarp*: One-loculed, one-seeded, ovoid, usually much collapsed and distorted, having a subapical light brown spongy looking appendage (style base) about 0·4 mm. broad. Surface smooth, very finely pitted, pits about 0·008 mm. in diameter, wall as seen in

section compact, hard, about 0·025 to 0·05 mm. thick, columnar, lined by a coat of equiaxial or subequiaxial cells, about 0·03 mm. in diameter, with finely digitate walls. In section, the style base is seen to arise out of a plug-like structure which closes a gap in the columnar walls (Text-fig. 14). On its inner face is the placenta with remains of a pendulous seed represented by thin shrivelled testa. Length of carpel, 1·8 to 2 mm.; breadth (usually much collapsed), 1·15 to 1·35 mm.

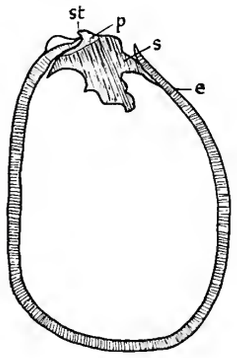


Fig. 14. Moraceae. Genus? Diagrammatic longitudinal section through endocarp showing style, *st*; placenta, *p*; seed, *s*; and endocarp wall, *e*.

Remarks and Affinities. Nine fruits of which the form, arrangement of placenta and solitary pendulous seed and structure of wall indicate the family Moraceae. Although the specimens are collapsed and shrivelled the hard well-developed carpel wall suggests that they were mature. It is therefore improbable that they represent immature fruits of either *Morus* (p. 76) or *Becktonia* (p. 77). In addition to the figured specimens from Sandbanks and Brank-some Dene there are four from Sandbanks (V.43501), one being dissected to show internal structure.

Order *CENTROSPERMAE*

Family CARYOPHYLLACEAE

Genus HANTSIA Chandler, 1960: 209

Hantsia pulchra (Chandler)

Plate 11, figs. 28–37

1925 *Corydalis pulchra* Chandler, p. 25, pl. 3, fig. 10*a*, *b*.
1960 *Hantsia pulchra* (Chandler): Chandler, p. 209, pl. 31, fig. 39.
1961*b* *Hantsia pulchra* (Chandler): Chandler, p. 114, pl. 25, fig. 40; text-fig. 2.

Diagnosis. Seeds 1·75 to 2·5 mm. in diameter. Testa tubercled.

Holotype. V.20051 from Lower Headon, Hordle, Hampshire.

Description. As published in Chandler, 1961*b*. Dimensions of a seed from the Lignite above the Boscombe Sands: 2·3 mm. (measured across the two limbs) by 2.4 mm. Other

specimens from this horizon too incomplete for measurement but approximating closely in size to those from Hordle.

Remarks. Seeds, much crushed and perishable, are frequent in the Lignite above the Boscombe Sands, Southbourne. At least five specimens originally showed the hilar opening and parts of two limbs and a dozen more broken seeds were also found. These seeds are less frequent in the Leafy lenticle of the Marine Beds, cliff base, Southbourne (V.43279), but a good small seed was found in the Marine Beds just east of the East Cliff lift, Bournemouth (V.43282). Material from both localities is figured. V.43279 displays the cell structure of testa and tegmen particularly clearly. It was originally the mode of cracking of this specimen which suggested that the tubercled areas may be built up of small angular equiaxial cells, about 0·016 mm. in diameter or rather larger, into which they tend to break down, a feature seen also in specimens from Hordle. Three seed fragments were found in the Highcliff Sands, Cliff End, near Mudeford.

The reason for assigning the species to the Caryophyllaceae are discussed by Chandler (1961*b*).

Family NYMPHAEACEAE

Genus BRASENIA Schreber

Brasenia ovula (Brongniart)

Plate 11, figs. 38–42

1926 *Brasenia ovula* (Brongniart): Reid & Chandler, p. 99, pl. 6, figs. 15–18. See also for other references.
1960 *Brasenia ovula* (Brongniart): Chandler, pp. 210, 224, pl. 31, figs. 40, 41; pl. 33, figs. 106, 107.
1961*b* *Brasenia ovula* (Brongniart): Chandler, p. 116. See also for earlier reference.

Seeds of *Brasenia*, usually represented by incomplete specimens or fragments of the brittle testa are common in the Marine Series. They have been found at Honeycomb Chine, Boscombe, in the sands at the Southbourne cliff base, in the carbonaceous beds underlying and the Lignites overlying the Boscombe Sands, Southbourne. They also occur in fragments in the Highcliff Sands, Mudeford. Some specimens show the characteristic embryotega or the aperture it occupied, all show the smooth surface and interlocking digitate cells. Worn fragments display on the inner side coarse equiaxial cells (Pl. 11, fig. 42). As always in this species there is great variation in size. It has not yet been found in beds underlying the Marine Beds but is common in the younger Eocene and Oligocene strata, where some seams are black with well-preserved unbroken seeds. V.43288 is unfigured material from the base of the Boscombe Sands and V.43291–93 from the Highcliff Sands.

Genus PALAEONYMPHAEA Chandler, 1961: 64

Palaeonymphaea eocenica Chandler

Plate 12, figs. 1–6; Text-fig. 15

1962 *Palaeonymphaea eocenica* Chandler, p. 60, pl. 7, figs. 19, 20.

The species was fully described in the above work, the description being based on well-preserved material from Sandbanks. The holotype was figured in 1962 and four additional

Fig. 15. *Palaeonymphaea eocenica* Chandler. Diagrammatic drawing of testa cells.

seeds from Sandbanks are shown here. There are also five unfigured seeds (V.43298), two figured specimens from Branksome Dene and about thirty (V.43301–02) unfigured seeds. No seeds have yet appeared from the Marine Beds or later horizons.

Genus?

Plate 12, figs. 7, 8; Text-fig. 16

DESCRIPTION. *Seed*: Subovoid but much compressed (represented by one-half only, the seed having split longitudinally in the plane of symmetry). Rounded at the chalazal end very slightly, more convex along one lateral margin than along the other, truncate at the hilar end where there is a large rimmed aperture from which an embryotega has presumably fallen away; the edges of the aperture are thin and smooth ('finished'), not abruptly truncate as is the case with the fractured edges of testa. The raphe cannot be distinguished, but its course may have lain along the less convex longitudinal side of the seed as suggested by an oblique depressed area which starts near the aperture and passes diagonally across the rim towards

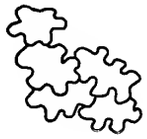


Fig. 16. Nymphaeaceae. Genus? Diagrammatic drawing of testa cells.

the less convex margin. Three regions can be distinguished in the testa: (i) an outer light-brown, shining layer or skin preserved in patches only, evidently readily detachable, formed of equiaxial inflated cells about 0·01 to 0·012 mm. in diameter. (ii) A median layer occupying most of the thickness of the testa, about 0·75 mm. thick. It has large sinuous or digitate cells (Text-fig. 16) with from three to about six or more digitations. The cells (including the digitations) are about 0·05 mm. in diameter and are markedly convex superficially and arranged approximately in longitudinal rows. In section it is formed of columnar cells which subdivide at their extreme inner ends so as to produce (iii) a layer of small cells lining the seed cavity (not everywhere seen or preserved). These cells are angular, 0·01 to 0·012 mm. in diameter. Length of seed, 4·3 mm.; breadth (as crushed), 2.95 mm.

Remarks. Half only of a longitudinally fractured seed found at Branksome Dene. The clawed cells, columnar coat and large aperture at the hilar end indicate the family Nymphaeaceae, but the nearer relationship to living forms is not clear. The species is about twice the size of *Palaeonymphaea eocenica* and is further distinguished by the convex outer ends of the coarse sinuous or digitate cells. It is larger than any fossil species of *Brasenia* seen. More material is needed for the complete elucidation of its structure and relationship, but clearly it represents a new species and perhaps a new genus. There is some resemblance in form and in the digitate cells of the testa overlain by a shining outer coat of equiaxial cells to the genus *Staphylea* but in that genus the coat with digitate cells is definitely not columnar in section, hence such a relationship can be excluded.

Genus?

Plate 12, fig. 9

Description. *Seed*: Subglobular (although flattened in fossilization) the globe truncated by a large, originally circular aperture which was presumably closed in life by an embryotega as in *Brasenia*, *Nuphar*, *Nymphaea* and other genera of Nymphaeaceae. Owing to the crushed condition, no longitudinal raphe ridge (if present) can be detected. Surface black and shining, finely and evenly punctate all over owing to the large conspicuous lumen of each cell of which the testa is composed. Cells equiaxial, polygonal, about 0·018 mm. in diameter, the lumen occupying approximately half the diameter of each cell. Length of seed, 2·75 mm.; breadth as flattened, 2·5 mm. Diameter of flattened aperture, 1·25 mm.

Remarks. One seed only has been seen with the general appearance of a water-lily but as no living genus of water-lily examined shows the smooth pitted surface here described, the specimen can only be referred tentatively to the family. It was found in the base of the cliff between Alum Chine and Branksome Dene behind a broken promenade (1956).

Family MENISPERMACEAE

Section COCCULEAE Diels

Subsection COCCULINAE Diels

Genus PALAEOCOCCULUS Chandler, 1961:330

Palaeococculus lakensis Chandler

Plate 12, fig. 16

1961 *Palaeococculus lakensis* Chandler, p. 330, pl. 33, figs. 8–10.
1962 *Palaeococculus lakensis* Chandler: Chandler, p. 63, pl. 7, figs. 23–29; pl. 8, figs. 1–3; text-fig. 12.

A small fragment of the highly characteristic endocarp was found in the Marine Beds at Honeycomb Chine. It shows the more or less smooth marginal flange and the corresponding broad internal suture. Only a few obscure flutings are preserved externally on the flange. Part of the sharply differentiated inflated external area overlying the locule cavity is seen. It is separated from the flange by a definite slightly channelled ridge (part of the horse-shoe shaped

ridge). Remains of a fibre lie within the channel. A few of the external, conspicuous, well-spaced, sharp, radial ridges of the inflated area are preserved. Surface characteristic, smooth and shining. Although the fragment is so incomplete its identity is clear and it is important as affording evidence of the genus and species in beds above the London Clay and the Dorset Pipe-clay Series (Cuisian?). In other fossil genera and species of Menispermaceae the marginal rim is markedly ribbed and fluted and partly overlies the marginal locule while the sharp, upstanding, horse-shoe shaped ridge corresponds with the inner not with the outer curve of the locule so that it directly abuts on the sunk area between the limbs of the curved cavity. Width of marginal suture in this fragment (inner surface), 0·2 mm. Width of limb (locule and flange), 0·5 mm.

Genus PALAEOSINOMENIUM Chandler, 1961 : 159

Palaeosinomenium hantonense n. sp.

Plate 12, figs. 10, 11

DIAGNOSIS. Endocarp curved obliquely, narrowly horse-shoe shaped, convex ventrally. Foramen between limbs elongate, oblique, its lower end touching a line drawn between the extremities of the two limbs. Surface with conspicuous nodular prominences on the outer and inner sides of the horse-shoe shaped ridge, those outside being continued onto the marginal flange. Diameter of endocarp, 3·5 by 2·7 mm.

HOLOTYPE. V.43306.

DESCRIPTION. *Endocarp*: Bisymmetric, laterally flattened, formed of two equal valves which separate on germination in the plane of symmetry. Suboval in outline, oblique, convex along the basal margin. Marginal flange horse-shoe shaped, broad (0·55 mm. where broadest), narrowing towards its extremities, delimited on its inner edge by an upstanding horse-shoe shaped ridge grooved along the crest. Ridge with nodular prominences on its outer side separated by deep furrows, some of the prominences being continued onto the flange, even perhaps to the margin of the endocarp although their precise limits are obscured by sand pitting and abrasion. Inner side of ridge also nodular the prominences quickly dying out on a central concave area between the arms of the ridge. Endocarp pierced close to the base by a narrow oblique foramen (0·4 by 0·13 mm.) nearer to the stylar than to the opposite limb, its lower ends touching a line drawn between the extremities of the two limbs of the horse-shoe. Surface of radially aligned cells or fibres seen on the flange but elsewhere partly obscured by sand pitting. Longest diameter measured along oblique axis of endocarp, 3·5 mm.; diameter at right angles to this, 2·7 mm.

REMARKS AND AFFINITIES. One specimen from Sandbanks, almost perfect in form, which indicates relationship with Cocculinae of the type of *Menispermum* and *Sinomenium*. There is a close resemblance to *Palaeosinomenium obliquatum* (Chandler, 1925: 24, pl. 3, fig. 9*a*, *b* and Chandler, 1961*b*: 118, pl. 25, figs. 47–50) but the Sandbanks endocarp differs in its narrower form, convex basal margin, and in the position of the foramen which in *P. obliquatum* lies well above a line drawn between the extremities of the two limbs of the horse-shoe ornamentation. It differs also in the presence of conspicuous nodular prominences on the inner side of the horse-shoe shaped ridge. It differs from the species next described in the character of the

base, the marked nodulations separated by deep pits, in the greater degree in which the nodulations are continued onto the flange and their development on the inner side of the horse-shoe shaped ridge, also in the position of the foramen.

Palaeosinomenium sp.

Plate 12, figs. 12, 13

DESCRIPTION. *Endocarp*: Truncate-suboval in outline, slightly oblique, laterally compressed, formed of two equal valves with a flattened scarcely fluted marginal flange narrowing towards the truncate base, delimited on its inner side by an upstanding, broad, horse-shoe shaped ridge 0·3 mm. in the widest part preserved, grooved along its crest. The ridge is conspicuously and regularly fluted on its outer side but not on its inner. It delimits a sunk central area between the limbs of the horse-shoe shaped locule. Foramen elongate, about 0·5 by 0·07 mm., nearer to the stylar than to the opposite limb, beginning at about 0·1 mm. from the truncate margin of the endocarp. Surface smooth. Cells radially directed on the flange. Length of endocarp incomplete, 2·4 mm. remaining (i.e. about two-thirds of the estimated length).

Seed: Represented by remains of testa formed of equiaxial cells 0·016 mm. in diameter.

REMARKS AND AFFINITIES. The incomplete specimen from the Highcliff Sands, Cliff End, Mudeford, shows corresponding parts of two valves but the rounded apex and almost the whole of the cotyledonary limb are missing. While form and ornamentation point clearly to Cocculinae of the type of *Sinomenium* and *Menispermum* it differs from these genera in its narrow suboval form and elongate foramen. It differs from *Palaeosinomenium* sp. (Pl. 12, figs. 14, 15) in the flatter, less excavated base, relatively broader marginal rim, more regular and conspicuous nodulations which abut upon it, wider, grooved, horse-shoe shaped ridge, depressed central area, narrower foramen and probably in its greater proximity to the base. No specific name has been given as there is only one imperfect specimen.

Palaeosinomenium sp.

Plate 12, figs. 14, 15

DESCRIPTION. *Endocarp*: Obcordate (very slightly broken at the base), laterally compressed, splitting into equal valves marginally (only one preserved), with flattened, obscurely fluted, marginal flange which narrows towards the stylar limb. Flange delimited along its inner edge by an upstanding horse-shoe shaped ridge which is nodular or fluted on its outer side, the nodules dying out rapidly on the flange. A well-marked groove lies along the highest part of the ridge. There is a smooth, flat, slightly elevated, central area bounded by the ridge. Foramen narrow oval, 0·5 by 0·15 mm., somewhat nearer to the stylar than to the opposite limb of the curved endocarp. Surface smooth, radially striate on the marginal flange. Endocarp wall about 0·025 mm. thick. A flat internal marginal suture, 0·2 to 0·3 mm. broad, corresponds with the external flange. The locule is broad dorsiventrally with short limbs, probably separated originally by a broad triangular condyle (broken in part). Locule surface, much worn, of equiaxial cells producing obscure striations. Maximum diameter of endocarp, 3·75 mm.; breadth across the two limbs, 2·5 mm.

Remarks and Affinities. One valve from the Highcliff Sands, Cliff End, Mudeford, originally complete except at the extreme base between the two limbs, now broken longitudinally obliquely. Like the previous species it differs from *Sinomenium* and *Menispermum* in its narrow form, relatively broad suture and elongate foramen. It also differs in the raised area between the limbs. From *Palaeosinomenium* sp. (p. 83) it is distinguished by the more emarginate base, relatively narrow marginal rim, less regular and conspicuous nodulations, narrower grooved horse-shoe shaped ridge, raised central area and (probably) in the greater distance of the foramen from the base.

Genus WARDENIA Chandler, 1961:158

Wardenia marginata n. sp.

Plate 12, figs. 17–22

Diagnosis. Endocarp much compressed laterally with broad marginal flange. Ventral margin almost straight. Foramen situated at about its own length from this margin. Nodular ridges arising from the outer side of the horse-shoe shaped ridge are continued on the marginal rim for about two-thirds of its width where they terminate abruptly with blunt ends. Diameter of endocarp about 3·5 by 3 mm.

Holotype. V.44309.

Description. *Endocarp*: Bisymmetric, laterally flattened, formed of two equal valves which separate in the plane of symmetry on germination. Suboval to gibbous in outline but sometimes much distorted so as to be narrowly or broadly suboval. Slightly oblique (very oblique only in a distorted specimen), flat or scarcely concave along the ventral margin, having a broad marginal horse-shoe shaped flange, 0·9 mm. broad in its widest part (i.e. almost one-third the width of the endocarp) which narrows towards the extremities of the limbs. The flange is delimited along its inner edge by an upstanding almost symmetrical horse-shoe shaped ridge, rounded but with a narrow shallow inconspicuous groove along the crest. On the outer side of the ridge are elongate, rounded, nodular prominences separated by deep furrows, the prominences being continued onto the flange and ending bluntly about two-thirds of the width of the flange from the margin of the endocarp. Beyond these ridges and furrows the marginal flange is smooth or only obscurely and finely fluted. The inner curve of the horse-shoe shaped ridge is normally smooth and free from nodules in contrast to *Palaeosinomenium obliquatum* from Hordle and *P. hantonense* from Sandbanks in both of which it is nodular, finely so in the former, more coarsely in the latter, although in both the nodules quickly die out on the central area between the arms of the horse-shoe. This central area is relatively smaller in *Wardenia marginata* than in *Palaeosinomenium obliquatum* and *P. hantonense*. It may be concave, or almost flat and is pierced by a narrow elongate foramen, about 0·45 to 0·6 mm. long, which ends about 0·2 to 0·5 mm. from the ventral margin and lies somewhat nearer to the stylar than to the other limb. The surface is formed of fine radially aligned cells or fibres. Diameter of endocarp, 3·5 mm. measured across the two limbs; 3 mm. measured between the limbs. A distorted specimen measured 3·3 mm. across the limbs, 2·5 mm. between them (at right angles to the first measurement).

Seed: Horse-shoe shaped, testa translucent, formed of equiaxial cells, 0·012 mm. in diameter. The chalaza could be seen in the inner curve between the limbs.

Remarks and Affinities. All but two imperfect fragments were found in the Lignite above the Boscombe Sands, Southbourne. One endocarp is almost perfect, a second shows a perfect base but is broken at the rounded dorsal margin. In another specimen the base, end of one limb and elongate foramen are preserved. Two specimens are more or less perfect but greatly distorted and there are about eleven fragments mostly showing the marginal flange (V.43313).

They have been placed in the genus *Wardenia* Chandler based on an endocarp from the London Clay of Sheppey described as *W. davisi* (Chandler, 1961: 158, pl. 16, fig. 8). In *W. davisi* the rim is about one-quarter of the width of the endocarp and is thicker and more inflated than the rim of *W. marginata*. It is also a larger species (5 by 4 mm.) and its foramen is nearer to the ventral margin which is shorter and rather more concave than in *W. marginata*. Again in *W. davisi* the radial ridges on the rim do not terminate abruptly at some distance from the edge as in *W. marginata*.

The genus *Wardenia* is distinguished from other similar genera belonging to Cocculinae from the Hampshire deposits by the breadth of the marginal flange and the relatively small median area between the limbs; also by the coarse ridges which extend onto the flange from the outer side of the horse-shoe ridge. From *Palaeosinomenium hantonense* (p. 82) it is also distinguished by its concave or flat base, the greater symmetry of the curved limbs (giving a more symmetric 'horse-shoe' ornamentation) and the virtual absence of tubercles on the inner side of the horse-shoe shaped ridge. From *P. obliquatum* from Hordle (Chandler, 1925: 24, pl. 3, fig. 9*a*, *b*; 1961*b*, pl. 25, figs. 47–50) it is distinguished by the two last mentioned characteristics, while in both these species the ridges on the marginal flange are finer and sharper and the horse-shoe ornamentation is sharper and more conspicuously grooved.

Half a valve from the Leafy lenticle, cliff base, Southbourne, apparently belongs to *W. marginata* (Pl. 12, figs. 21, 22) but its stylar end is broken, the break passing through the foramen near the ventral margin. The length of the foramen may have been 0·5 mm., its lower end being about 0·2 mm. from the ventral margin. The width of its marginal suture on the inner surface of the valve is about 0·15 mm. and a short broad triangular condyle is seen on the inner surface near the base between the two limbs of the curved locule extending for about 1·2 mm. along the axis between the limbs. Diameter of endocarp between the limbs, 3·25 mm.; diameter across both limbs incomplete. A small marginal fragment of a valve showing the blunt-ended ridges was found in the Marine Beds, just east of East Cliff lift, Bournemouth (V.43315).

Family MAGNOLIACEAE

Genus MAGNOLIA Linnaeus

Magnolia sp. (?***M. angusta*** Reid & Chandler)

Plate 12, figs. 23, 24

1933 (?) *Magnolia angusta* Reid & Chandler, p. 177, pl. 5, figs. 6-8.
1961 (?) *Magnolia angusta* Reid & Chandler: Chandler, p. 164, pl. 17, figs. 3, 4.

DESCRIPTION. *Seed*: Subtriangular in outline, longer than broad, bluntly faceted on one surface (the faceting sharpened by collapse). Chalaza at the broad end, greatest diameter of chalaza, 1·1 mm. Testa columnar in section, 1·5 mm. thick near the chalaza, cells 0·012 to 0·016 mm. in diameter, surface cells obscured by sand pitting. Tegmen longitudinally striate around the chalaza from which the striae diverge. Length of seed, 3·9 mm.; breadth, 2·9 mm.

REMARKS AND AFFINITIES. One carbonaceous seed from Sandbanks split so that it shows the internal chalaza and the cell structure of the testa, both highly characteristic of *Magnolia*. The faceting shows that the seed was originally considerably inflated and triangular, distortion due to fossilization has pushed the chalaza onto the faceted face. The seed is much smaller than *M. angusta* from the London Clay which has a similar longer than broad form (Reid & Chandler, 1933: 177, pl. 5, figs. 6–8; Chandler, 1961: 164, pl. 17, figs. 3, 4) but the small size could be due to shrinkage of a carbonaceous specimen not distended by infiltrated pyrites and it is quite possible that the two are identical.

In a paper by Good (1925) certain facts about the distribution of the Magnoliaceae are pointed out: viz. their distribution centres in the south-east corners of the great northern land masses of both the western and eastern hemispheres, i.e. in the south-eastern United States and in Indochina respectively. From these, he stated, they spread throughout Central America and the West Indies into South America on the one hand and through the Malay Peninsula and over most of the Malay Archipelago on the other, their northern limits being the Great Lakes of North America and Japan. They extend from sea-level up to 12,000 feet; the majority at the higher levels. On the whole *Magnolia* tends to be temperate, the more temperate species being deciduous. The family occurs in regions of excessive precipitation and nowhere where the total rainfall is below about fifty inches annually or where there is a marked dry season. They do not occur where the average annual temperature is below 50° F. or north of the winter isotherm of 32° F. In summer all Magnoliaceae lie within the isotherm of 64° F. Good considered that the vastly greater areas once occupied by the Magnoliaceae were similar in climate to the areas where they occur today.

Family ANONACEAE

Genus ANONASPERMUM Ball emend. Reid & Chandler, 1933: 184

Anonaspermum sp.

Plate 13, figs. 1, 2

DESCRIPTION. *Seed*: Somewhat ovate in outline, flattened in fossilization, ruminate, having a marginal ridge or angle. Hilum indicated by an inconspicuous point at the broad end. Surface of testa apparently smooth, formed of small equiaxial cells aligned in rows about 0·01 mm. broad (now much obscured by sand pitting). Projecting 'tags' which formerly penetrated into the ruminate albumen (not preserved) are visible all over the inner surface of the testa. They are narrow, flattened, somewhat finger-like, many diverge from the margin towards the centre of the seed, others arise further from the margin but are also directed inwards. As they are of variable length they extend for different distances towards the centre of the seed but all apparently end before reaching the middle of its cavity. The surfaces of the

tags show fine striations and more conspicuous small equiaxial cells about 0·025 mm. in diameter. Length of seed, 5·5 mm.; breadth (estimated incomplete) about 5 mm.

Remarks. Part of the testa of one valve of a seed from Branksome Dene showing the typical form and ruminations of Anonaceae. The precise relationship within the family cannot be determined but clearly the seed was not of a type in which ruminations extend from side to side across the whole breadth of the seed on account of the discontinuity described above. Anonaceae are among the commonest London Clay fossils but the preservation there is entirely different owing to pyritization. Normally the testa is abraded, a pyrites cast showing the form of the albumen being the usual entity preserved. One seed (V.21217) was found in the Barton Beds (Chandler, 1960: 225, pl. 34, figs. 110–113) in which testa and albumen are both partly preserved.

Family LAURACEAE

Genus CINNAMOMUM (Tourn.) L.

Cinnamomum sp.

Plate 13, figs. 3, 4

Description. *Berry*: Originally ovoid but now flattened in fossilization, smooth and shining with large scar for peduncle. Cells of epicarp about 0·016 mm. in diameter, angular, more or less equiaxial and flat-topped and variable in appearance according to the mode of preservation, sometimes having sunk walls but in places on the surface being sunk with raised walls. The epicarp also shows irregularly scattered, depressed, circular areas about 0·025 to 0·03 mm. in diameter as in species of *Cinnamomum* from the London Clay. Larger berry 7 mm. long, 5 mm. broad, peduncle scar (flattened) 2 mm. in diameter (estimated, slightly incomplete). Smaller berry 5·6 mm. long, 4·75 mm. broad, peduncle scar complete 1·5 mm. broad.

Remarks. Four berries from Branksome Dene, two of which (V.43320) are unfigured, one being incomplete the other 9·5 mm. long, 8 mm. broad. Lauraceae berries especially when crushed and 'mummified' as in these examples are extremely difficult to determine as the succession of coats is not clearly preserved (in contrast to the pyritized London Clay berries). The size, form, form of the peduncle scar and the surface characters suggest *Cinnamomum*, a genus determined by Bandulska (1928: 145, pl. 8, figs. 7. 8) from leaf form with cuticle found at Durley Chine. The genus is abundant in the London Clay and has been repeatedly recorded as leaf impressions from Tertiary deposits.

Genus LAUROCARPUM Reid & Chandler, 1933:225

Laurocarpum sp.

Plate 13, figs. 5, 6

Description. *Berry*: Subovoid, surface smooth and shining with a complicated network of furrows separating rounded lobes probably due to shrinkage. Epicarp leathery, yellowish and translucent formed of a single layer, about 0·025 mm. thick, of equiaxial cells of variable

size, ranging from 0·012 to 0·016 mm. in diameter. Mesocarp very thin at least as contracted by drying and shrinkage. Endocarp columnar in section, about 0·05 to 0·075 mm. thick. Dimensions of berry, 13 by 10 mm.

Seed: Represented by an internal cast in fine white clay showing remains of raphe as branching fibres embedded in its surface.

Remarks. Two specimens found by Bandulska between Branksome and Canford Chines, one (V.43322) being a very imperfect cast lying in matrix partly covered by pericarp, the other now decayed. Although no attempt to determine the nearer relationship can be made the specimens clearly belong to Lauraceae. The condition of the berries below is too imperfect to show whether they had a cupule or a swollen peduncle.

Laurocarpum spp.

Plate 13, figs. 7–11

A few imperfect, ovoid, shining, leathery berries, several with peduncles swollen to form a small cupule, are too incomplete or too immature for closer determination. The largest complete berry (Pl. 13, fig. 7) is 4·5 mm. long and shows a circular scar of attachment about 1 mm. in diameter. Another is seated on a receptacle or small cupule but has lost much of the epicarp (Pl. 13, fig. 8). A small berry is only 2 mm. long (Pl. 13, fig. 9). There is a fragment of a much larger species of which only 4·5 mm. is preserved (Pl. 13, fig. 10) and in addition various fragments of berries and one peduncle with calyx still attached (V.43327). All are from a Leafy lenticle in the Marine Beds, cliff base, Southbourne.

There is also a large species with collapsed and puckered surface from the Lignite above the Boscombe Sands (Pl. 13, fig. 11).

Family CAPPARIDACEAE

Genus CAPPARIDISPERMUM Chandler, 1957:98

Capparidispermum poolense n. sp.

Plate 13, figs. 12–16

Diagnosis. Seed with U-shaped cavity having somewhat unequal limbs which separate at the hilar end. Radicular limb somewhat narrower than the rounded cotyledonary limb. Inner coat of testa formed by a single layer of large cells which give a foveolate appearance when collapsed, concealed by an outer coat of close-textured, fine parenchyma. Maximum diameter of seed measured across two limbs, 1·9 to 2·3 mm.; diameter at right angles to this about 1·8 mm.; thickness about 1 mm.

Holotype. V.43329.

Description. *Seed*: Subcircular or reniform in outline, bisymmetric with U-shaped cavity formed by a hard inner coat the curved form being somewhat concealed on the outer surface of the seed by a superficial smooth close-textured spongy coat which covers the junction between the limbs. Emarginate at the hilum lying between the free ends of the U which readily separate at their extremities leaving a conspicuous gap; there is a flattened longitudin-

ally striate funicle between the limbs. Seed much inflated, rounded at the margin either rupturing irregularly or splitting marginally in a more or less regular manner. Limbs unequal, micropyle terminal on the narrower limb, the other being broader and more rounded at the distal extremity. Chalaza not seen. Outer coat smooth, formed of parenchyma, cells about 0·025 mm. in diameter. Inner coat hard, compact, deeply foveolate externally, the pits arranged in concentric rows parallel with the curvature of the cavity and outline of the seed, somewhat elongate radially and becoming smaller towards the ends of the limbs and the centre of the seed. Larger pits about 0·1 by 0·05 mm. in diameter and about 0·03 mm. deep, occupying about two-thirds of the thickness of this inner coat. Whether these pits are single cells is not clear and the structure of the inner part of the coat is also obscure. Tegmen of several layers, the outermost of rectangular cells, 0·025 mm. in diameter with marked radial alignment (i.e. transverse to limbs of seed); within is a coat, one cell thick, of equiaxial cells, 0·025 to 0·03 mm. in diameter. The innermost layer is finely striate, striae about 0·01 mm. apart near the margin diverging from the area between the limbs, but actual cell structure obscure. Maximum diameter of seeds measured across limbs, 1·9 to 2·3 mm; diameter at right angles to this along plane between limbs about 1·8 mm.; thickness, 1 mm.

Remarks and Affinities. Eight seeds (some imperfect) from Sandbanks including V.43334 (unfigured material). All are much cracked and distorted. The subcircular seed emarginate at the hilum with U-shaped cavity and the foveolate coat with outer fine-textured integument relate these seeds to Capparidaceae. It has not been possible to place them in a living genus, probably through ignorance of living material. Moreover the fruit characters are unknown. All living genera examined which showed a comparable pitted coat are less transversely oval in form with a smaller less rounded cotyledonary limb while the pits tend to be coarser. The seeds are therefore referred to a form-genus, the specific name indicating the site (Sandbanks) near Poole Harbour.

Family HAMAMELIDACEAE

Genus PROTOALTINGIA Reid & Chandler, 1933:247

Protoaltingia hantonensis Chandler

Plate 13, figs. 17–20; Pl. 14, figs. 1–3

1961*b* *Protoaltingia hantonensis* Chandler: Chandler, p. 121, pl. 26, fig. 60.
1962 *Protoaltingia hantonensis* Chandler, pp. 69, 163, pl. 9, figs. 18–24; pl. 28, figs. 6-8.

The species was based on well-preserved material from the Freshwater Series found by Bandulska between Branksome and Canford Chines, and between Alum and Durley Chines. In addition to those figured in 1962 fruiting heads were found between Alum and Durley Chines (V.44996 and V.43348); between Branksome and Canford Chines (V.43068 an imperfect external mould about 6 mm. broad and the corresponding fruit) and at Sandbanks (Pl. 13, fig. 20, unfigured V.43336–38) about eleven fruits showing varying degrees of abrasion. An abraded head came from Branksome Dene (V.43069) and a poor impression from Durley Chine (V.43070 counterparts).

In addition to the above, specimens were collected in the Marine Beds; at Honeycomb

Chine (Pl. 13, fig. 17) and V.43349 and in a Leafy lenticle, cliff base, Southbourne, with endocarps preserved in some of its alveolae (Pl. 13, fig. 18; Pl. 14, fig. 2). One head came from a lignitic raft at the base of the Boscombe Sands (V.43347) while in the Lignite at the top of this bed the species was one of the commonest fossils in a condition prone to rapid decay or deterioration (Pl. 13, fig. 19; Pl. 14, figs. 1–3 and V.43345–46).

The affinities were discussed by Chandler 1962 and a record from Hordle previously erroneously described as *Liquidambar* sp. was corrected (Chandler, 1961*b*: 121, pl. 26, fig. 60).

Family HAMAMELIDACEAE

Genus?

Plate 14, figs. 4–8

Description. *Fruit*: Two-loculed, dehiscing loculicidally and septicidally, borne singly on a short twig with much puckered surface, not agglomerated as in *Altingia*, *Liquidambar*, *Bucklandia* and *Protoaltingia.*

Endocarp: Subovoid but somewhat laterally compressed, gaping loculicidally along a median suture on both broad surfaces, the split extending to about one-half to three-quarters of the length from the apex. Each endocarp originally one of a pair released from the exocarp and separated from the second carpel by septicidal dehiscence. Wall formed of transverse or oblique fibres subparallel with the free edges and diverging below from the termination of the loculicidal split. Length of endocarp about 1·75 mm.; breadth, 1·25 to 1·5 mm. (the larger dimension that of a specimen flattened in fossilization).

Remarks and Affinities. Three figured endocarps from Sandbanks and one imperfect fruit still attached to the peduncle. Also fourteen unfigured endocarps (V.43071) from Sandbanks. They correspond approximately in size with the alveolae of the fruiting heads in *Protoaltingia hantonensis*, but cannot belong to that species for the reason given above. They are smaller than living genera examined possibly in part as a result of shrinkage. No seeds were seen.

Family ROSACEAE

Genus RUBUS (Tourn.) L.

Rubus acutiformis Chandler

Plate 14, figs. 9–22

1925 *Rubus acutiformis* Chandler, p. 26, pl. 4, fig. 2.
1961*b* *Rubus acutiformis* Chandler: Chandler, p. 122.
1962 *Rubus acutiformis* Chandler: Chandler, p. 38, pl. 4, figs. 36-40.

The published descriptions are equally applicable to endocarps from Sandbanks and Branksome Dene in the Freshwater Beds and the Highcliff Sands at Cliff End, Mudeford. The Bournemouth specimens are 1·25 to 2·25 mm. long, 0·75 to 1·25 mm. broad, all are much abraded and sand pitted so that the characters of the ventral marginal flange are somewhat obscured. In addition to figured specimens from Sandbanks and Branksome Dene there are

numerous endocarps (V.43364–66, V.43359–61) from these localities, also spines probably of this species from Branksome Dene (V.43360) and the Lignite above the Boscombe Sands, Southbourne (V.43367). The endocarps from the Highcliff Sands are 1·7 to 2·15 mm. long and 1 to 1·5 mm. broad. V.43370–71 and V.43506 include unfigured spines and endocarps from this horizon. The species clearly ranges from the Lower Bagshot of Studland to the Hordle Beds.

?Family LEGUMINOSAE

Genus?

Plate 14, fig. 23

DESCRIPTION. *Seed*: From Sandbanks. Collapsed with smooth surface formed of fine pits, 0·007 mm. in diameter, such as are seen in *Pisum*. The thick black coat shows two fairly clearly differentiated layers; the outer 0·05 mm. thick and columnar in section, the columns being coarser than the surface pits, the inner of obscure structure much pyritized, only about half the thickness of the outer layer from which it is partially detached. Owing to the condition of the seed its original shape is uncertain and it cannot be determined. One part of the surface shows a definite curved furrow. Maximum diameter, 3·75 mm.

Genus?

Text-fig. 17

A shining fragment of testa (V.43505) about 2 mm. long from a Leafy lenticle in the Marine Beds at the base of the cliff, Southbourne, may perhaps belong to Leguminosae but is too imperfect for satisfactory identification. Its surface shows fine equiaxial cells, about 0·007 mm. in diameter, and depressions without clear walls or outlines formed by the ends of coarse

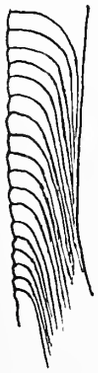


Fig. 17. Leguminosae. Genus? Diagram of testa as seen in section showing bending and narrowing of cells.

columnar cells which can be seen in sections of the testa. The columns are about 0·03 to 0·05 mm. broad. The whole integument is 0·125 mm. thick. As seen in section its outer part, 0·1 mm., is of the coarse columns described above, its inner part, 0·025 mm., is of elongate cells, 0·007 mm. broad, formed by the narrowing and bending of the columns of the outer part so that they lie parallel with the inner surface of the testa (Text fig. 17). Lining of seed-cavity longitudinally striate.

The shining thick black coat bears some resemblance superficially to the tegmen of Thymelaeaceae (p. 113) but its fine cell structure and the section with narrowed bent columns is unlike that family and suggests relationship with Leguminosae. As the form of the seed is unknown no attempt at determination can be made.

Family RUTACEAE

Genus PHELLODENDRON Rupr.

Phellodendron costatum Chandler

Plate 14, figs. 24–28

1925 *Phellodendron costatum* Chandler, p. 28, pl. 4, fig. 6*a–c*.
1961 *Phellodendron costatum* Chandler: Chandler, p. 75, pl. 7, figs. 10, 11.
1961*b* *Phellodendron costatum* Chandler: Chandler, p. 125.
1962 *Phellodendron costatum* Chandler: Chandler, p. 73, pl. 10, fig. 1.

Seeds exactly comparable with those described from Hordle and the Dorset Pipe-clay Series of Arne occurred at Sandbanks. The only additional observation is that remains of an external coat of narrow longitudinally elongate cells can be seen which is normally worn away. A perfect seed (V.43373) is 3·4 mm. in length; 1·8 mm. in breadth and 1·8 mm. in thickness. A second unfigured seed (V.43374) is represented by its ventral margin showing the characteristic hilar scar.

Genus TODDALIOSPERMUM nov.

Diagnosis. A form-genus for seeds which appear to be related to the section Toddalioideae but of which the nearer relationship is not known.

Type Species. *Toddaliospermum ornatum* n. sp.

Toddaliospermum ornatum n. sp.

Plate 14, figs. 29, 30

Diagnosis. Seed 3·75 to 4 mm. long. Thick coat of testa ornamented with pits about 0·03 to 0·05 mm. in diameter and slight interrupted ridges parallel with the dorsal margin about three or four pits apart.

Holotype. V.43395.

Description. *Seed*: Inflated, roundly cuneate in section, approximately bisymmetric, dorsal margin almost semicircular in outline, ventral margin scarcely convex at the chalazal end and at the opposite extremity, deeply excavated between owing to a gaping roundly triangular hilar scar with incurved margins; micropyle subapical on the ventral margin marked by a small transverse slit, raphe entering the testa at the broad end of the hilar scar. Testa formed of two coats. The outer coat smooth, of elongate cells or perhaps equiaxial cells arranged in rows with stronger longitudinal walls producing striae about 0·01 mm. apart. This coat, which is thin, overlies an evenly-pitted surface, the pits being sometimes equiaxial, about 0·03 to 0·05 mm. in diameter and having a tendency to be arranged in short rows of four or five pits.

The rows follow the curvature of the dorsal margin, the alignment being emphasized by slight interrupted ridges three or four pits apart in the same direction. Near the hilar scar the pits are less conspicuous and the alignment in short rows is obscure so that a smoother surface is produced, the smooth and pitted areas being delimited from one another by a slight hollow. Over the raphe the pits are longitudinally aligned but on the broad surfaces they diverge from the region of the hilar scar. Length of seed from Cliff End, Mudeford, 4 mm.; breadth, 2·5 mm.; thickness, 1·75 mm. Length of seed from the Lignite above the Boscombe Sands, Southbourne, 3·75 mm.; breadth, 2·5 mm.; length of hilar scar, 1·5 mm.

Remarks and Affinities. Two seeds, the Cliff End specimen is the better preserved except that it has lost its thin outer coat so that the outlines of the pits on the thick inner coat are sharper and more distinct than in the seed from Southbourne where they are seen only through the outer coat. The characters are clearly those of Rutaceae. The pitting and rugosities resemble those of *Phellodendron*, but it is distinguished from that genus by the form of the ventral margin and hilar scar. No living genus so far seen unites the characteristic form and sculpture of the fossil although its form recalls *Toddalia* and *Araliopsis* and it should probably be referred to the section Toddalioideae. It has been placed in a form-genus to indicate this relationship.

Toddaliospermum excavatum n. sp.

Plate 14, figs. 31–34

Diagnosis. Seed about 1·55 mm. long, much inflated. Surface with fine equiaxial cells 0·017 mm. in diameter and a few obscure ridges parallel with the dorsal surface.

Holotype. V.43397.

Description. *Seed*: Inflated, roundly cuneate in transverse section, bisymmetric, dorsal margin convex or gibbous in outline, ventral margin almost straight at the chalazal end, deeply excavated between the micropylar end and the middle owing to a short concave triangular hilar scar; micropyle apical on the ventral margin, raphe passing into the testa at the broad end of the hilar scar which as seen from the ventral edge has a notched appearance (Pl. 14, fig. 33). Surface ornamented with a few obscure concentric ridges parallel with the dorsal margin, testa formed superficially of fine equiaxial cells 0·017 mm. in diameter (but much abraded and consequently obscure). Length of seed, 1·55 mm.; breadth, 1·25 mm.; thickness, 0·9 mm.

Remarks and Affinities. One seed from Cliff End, Mudeford. The form and structure indicate relationship with Rutaceae. In the absence of further information regarding both fossil and living material it is referred to the form-genus *Toddaliospermum* (see p. 92). It is distinguished from *T. ornatum* by its smaller size, more inflated form, less coarsely-pitted surface and few coarse concentric obscure ridges parallel with the dorsal margin.

Genus RUTASPERMUM Chandler, 1957:102

Rutaspermum excavatum Chandler

Plate 15, fig. 3

1962 *Rutaspermum excavatum* Chandler, p. 73, pl. 10, figs. 2–13.

The species was based on well-preserved material from Sandbanks (V.41932–36). A few seeds were figured from Branksome Dene also (V.41937–38) and from the Dorset Pipe-clay Series at Arne.

One seed (V.43375) from the Lignite above the Boscombe Sands at Southbourne may belong to this species as suggested by its characteristic subglobular form, short, deeply excavated hilar scar and conspicuous slightly sinuous ridges. Its length and breadth are 2·5 mm.; thickness, 1·6 mm.; length of hilar scar, 1 mm. There are also unfigured seeds from Sandbanks (V.43376–77) and one from the Branksome Dene (V.43378).

Rutaspermum rugosum n. sp.

Plate 15, figs. 4–15

Diagnosis. Seed subovoid to gibbous in outline, much inflated. Hilar scar triangular, sunk when abraded, convex when best preserved. Thick coat of testa ornamented with longitudinal sometimes anastomozing and crested ridges with occasional transverse branches. Length of seed, 2·5 to 3·75 mm.

Holotype. V.43379.

Description. *Seed*: Bisymmetric, subovoid to gibbous in outline, ventral margin gently convex but truncated by a narrow triangular hilar scar (1·5 to 2·5 mm. long and about 0·4 mm. broad) extending for from half to three-quarters of the length of the seed. Surface of scar appearing sunk or convex according to the state of preservation and the degree of abrasion. Dorsal margin rounded. Lateral surfaces showing variable degrees of inflation, sometimes one surface is conspicuously less convex than the other (perhaps owing to the pressure of a second seed in the carpel). Micropyle at pointed end of the scar, raphe entering testa at the broad end by the hilar aperture which frequently, although not invariably, gives rise to a hook on the margin (Pl. 15, figs. 10, 11) the size of which varies with the degree of abrasion. Chalaza (Pl. 15, fig. 12) seen in broken seeds at the end of the longest diameter remote from the micropyle. Surface ornamented with longitudinal ridges diverging from the micropyle, continued over the broad faces and along the rounded dorsal side, converging towards the hilum. Ridges broad and blunt when abraded (Pl. 15, figs. 10, 11, 14), but sharp and conspicuously crested in places in unabraded seeds (Pl. 15, figs. 4–7), connected by transverse or oblique branches so that a reticulate pattern may be produced (Pl. 15, fig. 5). Comparison with Recent Rutaceae or with the fossil *R. excavatum* shows that the ribbed or reticulate surface does not represent the outer integument of the testa which has now disappeared (cf. *R. excavatum*, Chandler, 1962, pl. 10, figs. 12, 13). The hard testa preserved shows even fine pitting, the equiaxial pits about 0·025 to 0·05 mm. in diameter so arranged on the ridges as to produce transverse striations. These pits may actually be formed of smaller rounded equiaxial cells about 0·012 mm. in diameter. Wall in section about 0·35 mm. thick, cells corresponding with the superficial pits being arranged in a columnar manner at right angles to the surface. Locule lining of convex cells similar in size to those in the thickness of the wall. Tegmen translucent, light coloured, papery, subovoid, pointed at the micropyle with a large circular black chalazal scar about 0·25 mm. in diameter at the broader end. It immediately overlies the circular aperture in the hard testa which communicates with a basiventral raphe canal. Surface of tegmen finely striate longitudinally, striae about 0·001 mm. apart. There

are also indications of fine equiaxial cells whose relation to the striae is not clear. Length of seed, 2·5 to 3·75 mm.; breadth, 2·5 to 2·75 mm.; thickness, 1·5 to 2 mm.

Remarks. An abundant species in the lignites and carbonaceous beds at the base of and overlying the Boscombe Sands, Southbourne. In addition to the figured material over twenty specimens (V.43384–85) were found in the higher of these beds and a few fragments (V.43391–93) at the lower horizon. The seeds are very variable in size, degree of inflation and roughness of the surface. There is also some variation in the length of the hilum and in the degree of development of the hook at the entrance of the raphe, some of these variations at least being due to different degrees of abrasion. It does not seem possible to separate the variants into distinct species as they are connected by intermediate forms with one another.

A solitary incomplete seed was found in the Highcliff Sands, Cliff End, Mudeford (Pl. 15, figs. 14, 15). The testa was cracked and much decayed and the ridges, owing to abrasion, appeared more rounded than in much of the Southbourne material. The surface and internal pits in this seed are 0·017 mm. in diameter.

Among living Rutaceae *Zanthoxylum* appears to be the most comparable genus but no living species has the conspicuous longitudinal ridges of the fossil even after the removal of the thin papery epidermis.

Among fossil Rutaceae comparison was made with the Lower Headon species *Zanthoxylum hordwellense* Chandler (1961*b* : 123, pl. 26, figs. 63, 64) but this had a less inflated form, more excavated ventral margin and less conspicuous ridges and surface ornamentation.

Comparison with *Rutaspermum excavatum* Chandler (p. 93) shows that *R. rugosum* lacks the deeply excavated ventral margin usually flanked by curved, beak-like prominences at micropyle and hilar opening, is often relatively more inflated and has smoother less nodular and crested, longitudinal ridges, even allowing for changes due to abrasion.

Rutaspermum ornatum (Chandler, 1961*b*: 126, pl. 26, fig. 68; pl. 27, figs. 69–71) also from the Lower Headon is considerably larger (length of seed, 4 to 7·25 mm.; breadth, 3·5 to 4 mm.; thickness, 2·5 to 3 mm.) and differs in the conspicuous smooth marginal area around micropyle and hilar scar and over the raphe. Also it is commonly more elongate and more definitely hooked at the hilar opening.

Rutaspermum exaratum (Heer) from Bovey (Heer, 1862: 1079, pl. 70, figs. 24–27; Chandler, 1957: 102) is very closely comparable with the fossil here described. Unfortunately it is known from one seed only so the possible range of variation of the species cannot be assessed. It may be diagnosed in the following terms: Seed subglobular, hilar scar in upper part of ventral margin which it scarcely truncates so that it does not form an excavation in profile although the scar is concave in transverse section. Surface ornamented with slightly sinuous ridges, parallel with dorsal outline, converging to the chalaza, lying very close together and parallel to one another between chalaza and hilar aperture with some of the coarser lateral ridges converging towards the margins of the hilar scar. Surface finely pitted, pits 0·028, to 0·038 mm. in diameter. Length of holotype, 3 mm.; breadth, 2·5 mm.; thickness, 2·1 mm. Length of hilar scar, 2 mm.; breadth, 0·5 mm. This holotype is figured for comparison in Pl. 15, figs. 1, 2.

Zanthoxylum? *costatum* from the Bembridge Beds (Reid & Chandler, 1926: 114, pl. 7, figs. 20, 21) is more reniform and has a more triangular scar and less sharply ridged surface. Its length is 3 mm.; breadth, 2·3 mm.

Rutaspermum sp. (Chandler, 1960: 225, pl. 34, figs. 114, 115) from the Lower Bartonian (Horizon A) is, like *R. ornatum*, a much larger seed, as is *Rutaspermum* sp. (Chandler, 1960: 226, pl. 34, figs. 116, 117) also from Barton, distinguished further by its more or less smooth surface.

Family BURSERACEAE

Genus PALAEOBURSERA Chandler, 1961:202

Palaeobursera lakensis Chandler

Plate 15, figs. 16–21

1961*b* *Palaeobursera lakensis* Chandler: Chandler, p. 127, pl. 27, figs. 74, 75.
1962 *Palaeobursera lakensis* Chandler, p. 77, pl. 10, figs. 20–26.

The species is based on well-preserved endocarps from the Dorset Pipe-clay Series at Lake. Other pyrenes have since been found in the Bournemouth Freshwater Beds which are identical in form, anatomy and cell structure. Their length is 4 to 4·5 mm.; breadth, 1·75 to 2·5 mm. In addition to figured material there are eight specimens from Sandbanks (V.43399, V.43401) one of which (V.43401) shows the seed and part of the chalaza scar, and nine from Branksome Dene (V.43405). The species has also been recorded from Hordle.

Family EUPHORBIACEAE

Genus EUPHORBIOTHECA Reid & Chandler, 1933:284

Euphorbiotheca sp.

Plate 16, figs. 3, 4

Description. *Capsule*: Incomplete, multilocular (somewhat distorted in fossilization), showing one carpel seated on a leathery wrinkled calyx which arises out of a stalk with much puckered shining epidermis. Both calyx and stalk longitudinally striate with striae about 0·016 mm. apart. Calyx cup-like bearing short sepals at its rim. Dehiscence of capsule both loculicidal and septicidal, the septum showing a characteristic oblique fissure (Pl. 16, fig. 4). Axis short. One shrivelled seed seen within locule with finely striate testa, but structure otherwise obscure. Length of capsule, 1·6 mm.; length of calyx, 0·8 mm.; breadth of dorsal surface of one valve of the carpel, 0·7 mm.

Remarks. Mode of dehiscence and oblique fissure of the septum suggest the family Euphorbiaceae but no attempt to determine the nearer affinity can be made. From Sandbanks.

Euphorbiotheca sp.

Plate 16, figs. 1, 2

Description. *Fruit*: Three-carpelled, three-loculed, syncarpous, subglobular (compressed almost flat in fossilization) with thin exocarp, finely rugose externally formed of equiaxial cells about 0·01 mm. in diameter. Thin longitudinal ridges mark planes of loculicidal and septicidal dehiscence. Diameter (longitudinal and transverse), 2·5 mm.

Endocarp: Smooth, formed superficially of cells of similar size and shape to those of the exocarp arranged in oblique lines which diverge at sharp angles from the lines of splitting on the external surface. Locule surface of fine elongate cells diverging obliquely from the apical or subapical placentae.

Seed : Not seen.

Remarks and Affinities. One imperfect fruit broken so as to show a locule. The structure is typical of Euphorbiaceae and there is a resemblance to *Euphorbiotheca digitata* and to *E. platysperma* from the Dorset Pipe-clay Series at Lake. This Sandbanks specimen is, however, smaller and more finely and evenly rugose externally than either of these species and in the absence of fuller information, especially about the seeds, it is undesirable to attempt a specific determination.

Family ANACARDIACEAE

Section SPONDIAE

Genus SPONDIAECARPON Langeron, 1899:453

Spondiaecarpon operculatum Chandler

Plate 16, figs. 6, 7

1961 *Spondiaecarpon operculatum* Chandler, p. 216, pl. 21, figs. 37–39; text-fig. 27.

Description. *Fruit*: Pointed, elliptical in outline (much crushed in fossilization), bisymmetric about a median longitudinal plane, two-loculed, syncarpous, pointed at the apex where two ovate facets are inclined to one another at about 67°. On one surface they are separated only by a narrow tongue of the fruit wall. On the opposite surface there is a wide triangular prolongation of the fruit wall between them with slightly concave margins. Facets, formed by a pair of germination valves, one for each locule, 4 mm. long but owing to their oblique angle to the fruit axis they do not reach quite half way down the endocarp. Each valve has a median longitudinal ridge. Carpel wall forming a rim outlining the valves. Surface of fruit and valves finely punctate, pits being about 0·013 to 0·014 mm. in diameter. Length of fruit, 7·75 mm.; maximum breadth (as crushed and burst), 4·5 mm.

Remarks and Affinities. The solitary fruit from Branksome Dene agrees with *Spondiaecarpon operculatum* from the London Clay of Bognor one specimen of which showed valves as long in relation to the fruit as this Bournemouth example. In three others from Bognor the valves were somewhat shorter (2·5 mm.). Although the material is so limited the fruits from the two localities appear to be identical and have been referred to the same species.

Genus RHUS (Tourn.) L.

?***Rhus*** sp.

Plate 16, fig. 5

Description. *Fruit*: Represented by mesocarp fibres only, the fruit having become skeletonized. Original form asymmetric with style and attachment at the extremities of the

shorter margin. Fibres diverging from the base, bifurcating immediately once or twice and then converging to the apex (stylar end). These thick fibres (maximum thickness, 0·25 mm.) are attenuated upwards and impregnated with a secretion which in its dried condition makes them brittle. The base is provided with small sepal-like appendages outside the fibres. In one or two examples the fibres are connected by fragile remains of a thin integument. Length of best preserved skeleton, 5·5 mm.; breadth, 3 mm.

Remarks and Affinities. Closely comparable with mesocarps of *Rhus* which readily separate from exocarp and endocarp and become skeletonized but are initially embedded in a delicate integument and associated with a resinous substance. The fruit in *Rhus* is asymmetric and its fibres diverge from the base as in the fossil and converge to the apex. Living species belonging to the comparable section Venenatae of Engler occur in North America, the Andes, Eastern and Central Asia. Condition too poor to permit of definite determination and specimens so fragile that they fall to pieces on exposure to air. They were found embedded in white sandy matrix between Alum and Durley Chines. In addition to the figured example, now fallen from the matrix, there are remains of about eight specimens (V.43064–67).

Family ICACINACEAE

Genus NATSIATUM Buch.-Ham.

Natsiatum eocenicum Chandler

Plate 16, fig. 8

1925 *Natsiatum eocenicum* Chandler, p. 29, pl. 4, fig. 7*a–d*; text-fig. 11.
1961 *Natsiatum eocenicum* Chandler: Chandler, pp. 76, 102, 110, pl. 7, figs. 14-17; pl. 10, figs. 23-26; pl. 11, figs. 24, 25.
1961*b* *Natsiatum eocenicum* Chandler: Chandler, p. 128.
1962 *Natsiatum eocenicum* Chandler: Chandler, p. 96, pl. 13, figs. 6–16.

Description. The external impression of a crushed, collapsed endocarp shows the characteristic reticulate surface, hollows on the original endocarp being represented by convexities and ridges by sharp furrows still with traces of carbonaceous matter. Remains of the funicular canal are seen on the left near the base. Outline of impression somewhat incomplete because, as a result of crushing and contraction the edge of the endocarp has produced a narrow belt of fine radial striae closely surrounding the reticulate impression.

Estimated length, 14 mm.; estimated breadth, 12 mm. These measurements although slightly larger than the shrunken carbonaceous endocarps from Hordle and Lake (references above) probably give the unshrunken dimensions since all carbonaceous endocarps show an appreciable degree of shrinkage when compared with external impressions in the matrix in which they may lie. The specimen was labelled '*Aniba* locality' by Bandulska and may therefore be presumed to come from the Freshwater Beds between Alum and Middle Chines, Bournemouth.

Genus STIZOCARYA Reid & Chandler, 1933:336

Stizocarya sp.

Plate 16, fig. 9

DESCRIPTION. *Endocarp*: Subglobular, one-loculed, obscurely bisymmetric with lateral funicle. External surface beset with short blunt-ended prominences, remains of hair-bases piercing the carpel wall externally, often but not invariably projecting at their inner ends also to form low prominences on the locule surface about 0·4 to 0·6 mm. apart. Prominences multilocular, their outermost layer a cylinder of fibres. Cells of outer part of carpel wall apparently with sinuous outlines but somewhat obscure. Cells of inner part with radiating sinuosities, at least 0·05 mm. in diameter. Wall about 0·3 to 0·6 mm. thick. Length of endocarp (as preserved), 6·5 mm.; breadth incomplete but probably approximating to the length judging by the curvature of the surface.

Seed: Represented only by shrivelled remains of yellowish semitranslucent testa. Cells obscure but angular, equiaxial and about 0·016 mm. in diameter.

REMARKS AND AFFINITIES. An incomplete endocarp too poorly preserved for specific determination. The form, cell structure so far seen and position of the lateral funicle, together with the characteristic hair-bases, point to *Stizocarya* of the family Icacinaceae. The hair-bases are noticeably more pyritized than the surrounding carpel wall hence their persistence as small projections. A smaller species than *Stizocarya communis* from the London Clay (length, 11 to 14·5 mm.) or a very small and perhaps shrunken specimen of that species. From the Lignite above the Boscombe Sands, Southbourne.

Family SABIACEAE

Genus MELIOSMA Blume

?*Meliosma sheppeyensis* Reid & Chandler

Plate 16, figs. 10–13

1933 *Meliosma sheppeyensis* Reid & Chandler, p. 378, pl. 18, figs. 31–33.
1961 *Meliosma sheppeyensis* Reid & Chandler: Chandler, p. 243, pl. 24, fig. 10.
1961*b* ?*Meliosma* sp., Chandler, p. 133, pl. 28, figs. 88, 89.
1962 *Meliosma* sp., (?*M. sheppeyensis* Reid & Chandler) Chandler, p. 100, pl. 14, figs. 3, 4.

DESCRIPTION. *Endocarp*: As described in 1933 and 1961 but somewhat ovoid. The funicular canal deep and funnel-shaped with the attachment at its base. It passes obliquely into the locule with inward sloping sides formed by the smoothly incurved ventral walls (Pl. 16, figs. 11, 13). Walls of endocarp 0·1 to 0·2 mm. thick lined by centipede-shaped cells with interlocking digitate walls. The cells diverge from the attachment around which they are relatively short and broad. Maximum length of an endocarp in plane of symmetry, 2·5 mm.; breadth (much distorted) in plane of symmetry, 2·5 mm.; maximum thickness of the single valve (V.43411) at right angles to plane of symmetry, 1 mm., hence complete thickness of two valves about 2 mm. Second endocarp (V.43410), length much reduced by distortion, not measured. Breadth, 2 mm.; thickness of the one valve at right angles to plane of symmetry, 1 mm., hence complete thickness, as above, about 2 mm.

Seed: Represented by shrivelled testa, obscure, striate, striae about 0·005 mm. apart, cells not clearly distinguishable.

Remarks. Two endocarps from Sandbanks one represented by a single valve, the second, originally complete, separated into its two symmetric valves so that it also shows the attachment and funicle. The small size may be due to shrinkage of the carbonaceous material. It is somewhat similar to *M. sheppeyensis* from the London Clay the greatest diameter of which in the plane of symmetry is 3 to 4 mm.; breadth in plane of symmetry, 3·5 to 4 mm.; thickness at right angles to plane of symmetry, 3 to 3·5 mm. These larger dimensions are easily accounted for by the distended condition of the London Clay specimens due to pyrites. The walls are similarly smoothly incurved to form the deep funnel-shaped ventral canal. Yet without more material the endocarps can only be related tentatively to *M. sheppeyensis*. They are comparable in size and character with two endocarps from Hordle (see above) which should perhaps have been provisionally referred to *M. sheppeyensis* although described only as *Meliosma* sp.

Family RHAMNACEAE

Genus RHAMNUS Linnaeus

Sub-genus FRANGULA Tourn. ex Hall

Frangula hordwellensis Chandler

Plate 16, figs. 14, 15; Text-fig. 18

1925 Rhamnaceae? Genus? sp. 2, Chandler, p. 31.
1926 Rhamnaceae? Genus? sp. 2, Chandler, pl. 5, fig. 2.
1961*b* *Frangula hordwellensis* Chandler, p. 131, pl. 27, figs. 85, 86; pl. 28, fig. 87.

Description. *Pyrene* and *Seed*: Together subcircular or broadly oboval in outline, much flattened, with marked excavation at the base where the hilar end of the seed projects beyond the endocarp which closely invests it. Apex slightly emarginate. One flattened surface with a median longitudinal suture. Endocarp formed superficially of somewhat irregular-sized equiaxial cells, about 0·012 to 0·016 mm. in diameter the smallest towards the base where it is readily detachable. Inner layers formed of oblique fibres giving a striate appearance. Seed where exposed at the base having a deep hilar excavation, narrowly oval in outline and provided with a low median ridge parallel with the long axis of the excavation and the broad surfaces of the seed. Testa formed superficially of convex finely digitate cells about 0·025 mm. in diameter, columnar in section the columns having slightly sinuous outlines due to the convexity of these cells piled one upon another. Thickness of testa at margin 0·1 mm. but as little as 0·05 mm. at the middle of a broad surface. In fossilization a superficial thin skin tends to become detached. Tegmen finely striate, cell outlines obscure. Length of pyrene and included projecting seed, 3·5 mm.; breadth, 2·75 mm. the dimensions of the seed approximating closely to those of the pyrene.

Remarks and Affinities. One pyrene, now dissected, from the Leafy lenticle in the Bournemouth Marine Beds, cliff base, Southbourne. It appears to be identical with a species

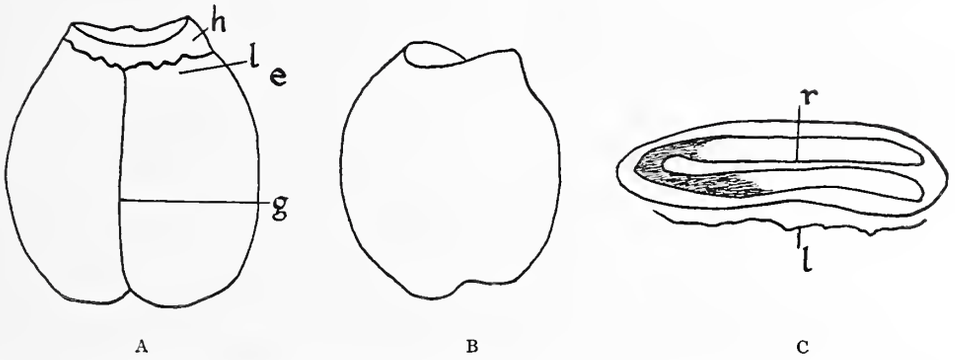


Fig. 18. *Frangula hordwellensis* Chandler. A, B, Opposite faces of pyrene. A, Face with median suture, *g*. C, Hilar end of seed in pyrene. *h*, projecting hilar end of seed with *r*, median ridge, seen in end view; *l*, loose flap of endocarp, *e*, investing seed.

from Hordle resembling a broader seed originally described as Rhamnaceae Genus? sp. 2. It is relatively narrower than this specimen but broader than the specimen taken as the holotype in 1961*b* where the distribution of the genus is given.

Family VITACEAE

Genus VITIS (Tourn.) L.

Vitis pygmaea Chandler

1961 *Vitis pygmaea* Chandler, pp. 77, 333, pl. 8, figs. 6, 7; pl. 34, figs. 5–11; text-fig. 3.
1962 *Vitis pygmaea* Chandler: Chandler, p. 100, pl. 14, figs. 5–31.

Numerous seeds from Sandbanks and Branksome Dene some of which were figured (Chandler, 1962), those from Sandbanks in pl. 14, figs. 20–27, those from Branksome Dene in pl. 14, figs. 28–31. Length of Sandbanks seeds, 2·25 to 2·6 mm.; breadth, 0·5 to 1·25 mm. Length of Branksome Dene seeds, 2·4 to 3·15 mm.; breadth, 1·75 to 1·95 mm. There appear to be no adequate reasons for separating the Branksome Dene seeds from others on account of their slightly larger size. Unfigured seeds from Sandbanks are V.43421.

Vitis sp.

Plate 16, figs. 16, 17

Description. *Seed*: Obovoid, much compressed laterally (partly an original feature), apex with shallow groove, base scarcely stipitate. Dorsal surface narrow, rounded and smooth, furrowed longitudinally between chalaza and apex; chalaza small, elongate oval, terminating at about one-third the length of the seed from the base, passing above into the narrow raphe. Ventral surface sharply faceted, facets meeting at an angle of about 60° (perhaps somewhat more acute than in the original uncompressed state). Raphe ridge sharply angled and therefore narrow, subparallel-sided, broadening gradually upwards owing to the slight upward divergence of the straight lateral infolds which occupy about one-half of the length of the seed

and arise at about one-quarter of its length from the base. Length of seed, 3·75 mm.; breadth, 1·75 mm.; thickness, 2·25 mm. One specimen (V.43413) from Sandbanks.

Vitis sp.

Plate 16, figs. 18, 19

DESCRIPTION. *Seed*: Obovate in outline, much compressed and collapsed dorsiventrally. Markedly stipitate, contours smooth. Dorsal surface only slightly convex both longitudinally and transversely without a furrow above or below the oval chalaza. Apex channelled, chalaza situated entirely above the middle of the seed in a slightly sunk area. Ventral face with conspicuous raphe ridge, infolds almost straight but diverging sharply upwards, extending for about half the length of the seed. Length of seed, 3·25 mm.; breadth, 2 mm.

REMARKS. One specimen so collapsed and distorted that it is difficult to determine the original form. No specific name is therefore given. From Sandbanks.

Vitis sp.

Plate 16, figs. 20, 21

DESCRIPTION. *Seed*: Obovate in outline (much compressed and abraded), not stipitate, angled on the ventral face the facets being unequal. On each side of the ventral ridge is a concavity the infolds being obscure as a result of crushing but there are indications that they were long, extending almost to the apex, and close together. Flanking the two concavities was an obscure marginal area, 0·6 mm. broad. Chalaza ill-defined owing to abrasion but apparently oval, approximately at the middle of the dorsal face and about 1 mm. long, 0·7 mm. broad. Surface pittings when outer skin removed, thin walled, about two pits occurring in a length of 0·05 mm. Length of seed, 5·2 mm.; breadth, 2·75 mm. From Sandbanks.

Vitis sp.

Plate 16, figs. 22, 23

DESCRIPTION. *Seed*: Subcircular in outline, contours smooth and rounded, not channelled at the apex, broken at the base. Dorsal surface lacking any marked groove between apex and chalaza but having a well-defined furrow below the chalaza extending towards the base (so far as that is preserved). Raphe merging gradually into the spathulate or oval chalaza which probably lay at about the middle of the dorsal surface and had two or three shallow furrows diverging from it on each side. Ventral surface (now flattened in fossilization) probably originally with rounded broad raphe ridge, infolds extending from below the apex to the base (so far as this is preserved), slightly convex towards the raphe ridge. Outer integument rough, formed of obscure cells. Hard inner integument with pitted surface, pits fairly thick walled from 0·012 to 0·025 mm. in diameter best exposed on the ventral side of the seed. Length of seed (incomplete at base), 3 mm.; breadth, 3 mm.

REMARKS. The single specimen bears some resemblance to *Vitis excavata* (Chandler, 1962: 108, pl. 15, figs. 29, 30) but is smaller (*V. excavata*, length 4·5 mm.; breadth 4 mm.) and has its chalaza lower on the dorsal surface and again there are no concavities flanking the

raphe ridge on the ventral side. The single battered seed from the Lignite above the Boscombe Sands, Southbourne, does not appear to justify the use of a specific name.

Vitis sp.

Plate 16, figs. 24–27

Four fragments of Vine seeds, too incomplete for specific determination, afford evidence of the family Vitaceae in the Highcliff Sands, Cliff End, Mudeford. Two fragments show one infold of the ventral surface while two show part of the dorsal surface, one being the apex above the chalaza, the other the chalaza itself.

Family TILIACEAE

Genus TILIA (Tourn.) L.

?*Tilia* sp.

Plate 16, figs. 28–32

Anthers found at Sandbanks were submitted to the late Dr. J. B. Simpson who made preparations of pollen, sending photographs and a brief description in the following words: 'The pollen grains of the Tiliaceae belong to the three-furrowed class of dicotyledonous grains, have a pore in each furrow, and a reticulate exine. In my experience, except in *Apeiba* and *Tilia* the furrows are usually normal structures of their kind, that is to say long and gaping in the middle. In *Apeiba* they are slit-like, and in *Tilia*, very short slits surrounded by an oval thickening of mesexine. *Tilia* grains, in general, are also highly oblate in shape, the furrows lying on the equatorial bulge. Because of their flattened shape the usual view of the grain is the polar one. . . . The fossil grains show the oblate shape, the three (occasionally four) furrows with their characteristic rim of thick mesexine around the slit in the ectoexine, and the finely reticulated pattern of the exine. In the process of fossilization the fossil grains have been squashed practically flat, and I have had difficulty in finding a really good plan view of a furrow to photograph, but the essential similarity [with *Tilia*] is evident. The two obvious points of difference between the fossil and the living types is the smaller size (about 25 to 28μ), and the more delicate exine of the former. The average equatorial diameter of the grains in the living species is about 40 to 45μ. *T. chinensis* is at one end of the range, and *T. endochrysea* at the other. Small immature grains of living species are thick walled in comparison with the fossil examples. It is difficult to say if these differences are sufficient to put the fossil in a new genus. I should say no, on the strength of the pollen alone. . . . It is very different from *Grewia*, *Triumfetta*, *Elaeocarpus*, *Echinocarpus*, etc.

'I have now a fair collection of modern *Tilia* from Asia, and undoubtedly *T. endochrysea* is the nearest in size and thinness of exine, but even it is very different in reality.'

The slides were retained by Dr. Simpson and the work has not been revised recently, the above extracts being from a letter written over twenty years ago. In Simpson's collection clearly the Tiliaceae were not fully represented and it is possible that if the fossil slides were now available for examination by a competent palynologist a different generic reference might

be given. Dr. D. H. Mai has recently pointed out (ex lit.) that pollen from Bovey referred by Simpson to *Tilia* (Chandler, 1957: 106, pl. 15, figs. 130–132) belongs to Tiliaceae-Brownlowieae basing his opinion on the published photographs.

Genus GREWIA Linnaeus

Section *Microcos* Miq.

Grewia minima n. sp.

Plate 16, figs. 33, 34

DIAGNOSIS. Endocarp three-loculed, sub-obovoid, about 2·5 mm. long. Locule lining longitudinally striate, walls formed throughout of parenchyma, surface cells often longer than broad producing obscure striations.

HOLOTYPE. V.43422.

DESCRIPTION. *Endocarp*: Hard, sub-obovoid, syncarpous, three-loculed, formed throughout of parenchyma; on the surface the cells are often longer than broad (about 0·05 by 0·03 mm.) the longer axis being aligned longitudinally so as to produce obscure striations; the wall is about ten cells deep, and from 0·15 to 0·25 mm. thick, in the thickness of the walls the cells are equiaxial, smaller than those of the surface, about 0·025 mm. in diameter. Locule lining shining and smooth, formed of longitudinally elongate cells (0·01 mm. broad, and up to 0·25 mm. long) which produce longitudinal striations diverging from narrow basal funicular openings. Length of endocarp, 2·5 mm.; breadth (as preserved), 1·5 mm.

REMARKS AND AFFINITIES. One imperfect endocarp from the Highcliff Sands, Cliff End, Mudeford. Two of the locules are exposed either by the disappearance of large valves or by accidental fracture. The third locule, lying between the other two, is apparent where the septum is broken in small patches; its presence is indicated externally by obscure shallow narrow grooves which appear to mark its lateral limits near the base of the endocarp; the grooves may indicate the edges of a valve.

The only similar hard multilocular syncarpous endocarps seen, with comparable longitudinally striate locules, belong to *Grewia* with which the fossil agrees closely in detailed structure. This genus may have from two to five locules, but stones with more than two locules are confined to the sections *Microcos* Miq. and *Vincentia* Bentham & Hooker. The range of the living genus is from Arabia to China and Japan, South Africa to Abyssinia and through the Malay Archipelago to Queensland; the section *Microcos* is found in Further India and China; the section *Vincentia* chiefly in the Mascarene Islands although *Grewia caffra* grows on the mainland.

Family DILLENIACEAE

Genus ACTINIDIA Lindley

Actinidia eocenica n. sp.

Plate 16, figs. 35–39; Pl. 17, figs. 1–5

1961*b* *Actinidia* sp., Chandler, p. 135, pl. 28, fig. 98.

DIAGNOSIS. Length of mature seeds about 2 to 2·25 mm. Foveolae of the surface about 0·05 to 0·1 mm. in diameter.

HOLOTYPE. V.43423.

DESCRIPTION. *Seed*: Bisymmetric, anatropous, subovate in outline somewhat laterally compressed. Hilum and micropyle contiguous at the narrow end, the former a large circular scar, about 0·2 mm. in diameter, the latter a small mucro from which the surface sculpture diverges. Surface deeply foveolate with hexagonal, equiaxial, or longitudinally elongate pits 0·05 to 0·1 mm. in diameter. The pits have a tendency to be aligned in longitudinal rows. Intervening ridges have a median line of weakness along which they readily split. Surface of pits finely reticulate, reticulations being about 0·012 mm. in diameter. Testa about 0·025 mm. thick where measured, its inner surface with convexities formed by the inner ends of the large external foveolae. Tegmen thin, papery, formed of small cells about 0·012 mm. in diameter. Length of a small, perfect but possibly abortive seed, 1·6 mm.; breadth, 0·8 mm. Length of a second seed (not quite complete), 2 mm.; breadth (somewhat crushed and folded), 0·9 mm. Length of a third, perfect specimen, 2·25 mm.; breadth (crushed), 1·5 mm. Length (slightly imperfect) of a seed from the Highcliff Sands, near Mudeford, about 1·9 or 2 mm.; breadth (cracked and gaping) about 1·3 mm.

REMARKS AND AFFINITIES. The species is represented by several specimens from Sandbanks, one small but perfect seed from Branksome Dene and a cracked and now broken seed from the Highcliff Sands, Cliff End, Mudeford. The holotype from Sandbanks shows the closely adherent remains of a second well-developed seed on which hilum and micropyle are clearly preserved. Form, size, arrangement of organs and histological structure indicate *Actinidia*. The same species occurs in the Lower Headon of Hordle but as it was represented by only one imperfect specimen broken at the proximal end no specific name was given when it was described by Chandler (1961*b*). In view of the better seeds now available the species has been named *A. eocenica*. The living genus is restricted to eastern Asia. V.43428 includes unfigured fragments from Sandbanks.

Actinidia poolensis n. sp.

Plate 17, fig. 6

1962 *Actinidia* sp., Chandler, p. 111, pl. 16, fig. 1.

DIAGNOSIS. Length of flattened seed about 1·9 mm.; breadth, 1·25 to 1·4 mm. Appreciably smaller than mature seeds of *A. eocenica* with fewer lines of pits both transversely and longitudinally which therefore give a relatively more coarsely pitted appearance.

HOLOTYPE. V.43431.

DESCRIPTION. *Seed*: Obovate in outline (much compressed in fossilization), chalazal end rounded, hilar end pointed showing adjacent openings of hilum and micropyle. Surface deeply foveolate with mostly equiaxial, hexagonal, or polygonal pits varying in size in different parts of the seed, the largest about 0·1 mm. in diameter. Small polygonal areoles are seen on the surface of the pits producing a fine reticulation. Sutures on intervening ridges not clearly displayed. About fifteen rows of pits occur across the breadth on one side in the widest part of

the seed while there are about twenty pits along the middle of the broad surface in a longitudinal row. Length of seed, 1·9 mm.; breadth (as compressed), 1·4 mm.

Remarks. A single seed from Sandbanks which agrees in size and character with a seed (broken at the hilar end) from the Dorset Pipe-clay Series of Lake. The preservation of the Lake seed shows clearly the sutures along the ridges between the pits and there are twelve pits in a transverse row at the broadest part of the seed which is of approximately the same size. When inflated, prior to fossilization, these seeds must have been appreciably smaller than those of *A. eocenica*. The Lake seed is incomplete so that the thickness of the testa (about 0·025 mm.) is visible and shows that there is a single layer of cells, the foveolae being impressed onto the inner surface so as to form corresponding convexities separated by sutures as in living *Actinidia*. The foveolae agree in size and structure with those of the Recent *Actinidia kolomixta*. As the species appears to be readily recognizable and distinctive the specific name *A. poolensis* has been given, both specimens being derived from deposits close to Poole Harbour, Dorset.

Family THEACEAE

Section THEEAE

Genus GORDONIA Ellis

?*Gordonia truncata* Chandler

Plate 17, figs. 7–9

1926 *Gordonia truncata* Chandler, p. 35, pl. 6, fig. 4*a*, *b*; text-fig. 17.
1961*b* *Gordonia truncata* Chandler: Chandler, p. 136.

Description. *Fruit*: A five-loculed syncarpous capsule, imperfect at the apex with broadly truncate base, dehiscing loculicidally from the apex down to about 0·6 to 0·75 mm. from the base below which the carpels do not separate but remain attached to one another and to the central axis. Septa thick below but evidently thin above where they have broken away leaving the base of the persistent axis upstanding as a five-angled column. Dorsal walls of capsule also thinning at the lateral edges of the valves and upwards, their free margins smoothly finished. Surface (as now preserved) rough, obscurely and finely ridged longitudinally but smoother in the upper part. Length preserved, 2·5 mm.; maximum breadth, 2·25 mm.; maximum breadth of basal truncation, 1·5 mm. Estimated complete length about 7·5 mm.

Remarks and Affinities. The solitary fruit was found in the Highcliff Sands, Cliff End, Mudeford. Its characters are those of *Gordonia* (cf. Chandler, 1926: 34, 35) but no complete comparison with the Hordle fruits is possible owing to its broken condition. The broad base makes it more comparable with *G. truncata* than with *G. minima* but in view of its smaller size (actual length of *G. truncata*, 9 mm.; breadth, 3·5 to 5·5 mm.) it is only referred doubtfully to the former of these two species.

Section TAONABEAE

Genus EURYA Thunb.

Eurya mudensis n. sp.

Plate 18, figs. 6–11; Text-fig. 19

DIAGNOSIS. Seed variable in outline, subcircular to transversely oval. Seed cavity as in *Eurya becktonensis*. Surface pits somewhat finer than in *E. becktonensis* often about 0·05 by 0·025 mm. in diameter. Diameter of seeds, 1 to 1·5 mm.

HOLOTYPE. V. 43477.

DESCRIPTION. *Seed*: Very variable in form, size and sculpture. Bisymmetric, subcircular, suboval, transversely suboval or irregular in outline, more or less inflated. Cavity curved, reniform owing to an internal projection of the testa on the ventral side of the seed

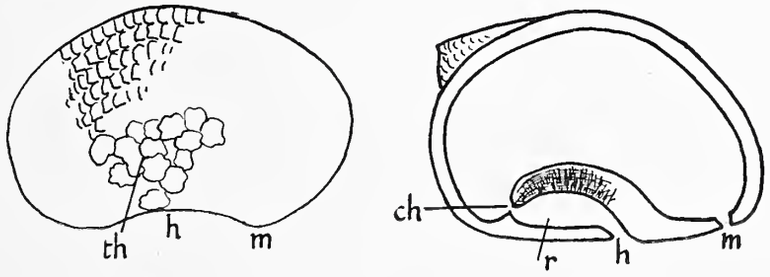


Fig. 19. *Eurya mudensis* n.sp. A, Seed, side. *m*, micropyle; *h*, hilum; *th*, thickening of testa formed of coarse cells overlying raphe cavity. B, Valve of seed, inner surface, showing curved cavity, internal projection of testa delimiting raphe cavity, *r*; *ch*, chalaza; *m*, micropyle; *h*, hilum.

which forms the inner boundary of a fusiform or oval cavity for the passage of the raphe from the marginal hilum to the subterminal chalaza near one extremity of the seed cavity. Micropyle near the hilum, terminal at the opposite end of the seed-cavity, closed by a small, brown, round plug from which the testa cells diverge. Hilum median on the ventral margin and somewhat nearer to the micropylar than to the chalazal limb. Surface foveolate, the deep pits usually radially elongate and aligned from the hilar region frequently about 0·05 by 0·025 mm. in diameter. Testa variable in thickness in different parts of the seed, especially thick in the hilar region and in the internal projection described above. Greatly thickened on the sides of the seed overlying the raphe cavity where there is a superficial development of coarse equiaxial pits which measure about 0·1 to 0·15 mm. in diameter (Pl. 18, figs. 7, 8). In section the testa is formed of several compact layers of equiaxial cells, 0·016 mm. in diameter. Seed cavity with cells aligned transversely to the length. Dimensions of seeds: 1) Length and breadth, 1·5 mm. 2) Length, 1·25 mm.; breadth, 1 mm. 3) Length and breadth, 1·1 mm. 4) Length, 0·9 mm.; breadth, 1·1 mm. 5) Length, 1 mm.; breadth, 1·5 mm.

Remarks and Affinities. Six seeds from the Highcliff Sands, Cliff End, Mudeford, and two doubtful specimens one of which is very small. Also five unfigured specimens (V.43483–84). The reniform cavity indicates affinity with *Eurya* of *E. japonica* type and *Adinandra*. The ingrowth from the testa is developed almost exclusively on the micropylar side of the hilum as seen in longitudinal sections of the seed and not on both sides of it to form a long clavate condyle as in *Cleyera* and the fossils *Cleyera*?. The resemblance to *Eurya* is closer than to *Adinandra*. *Eurya mudensis* is clearly distinguished from *E. becktonensis* Chandler (1961*b*: 136, pl. 28, fig. 103) by its smaller size and surface pits, possibly also by its more variable outline but this cannot be confirmed without a larger range of seeds from Hordle.

Sub-genus CLEYERA DC.

Cleyera? *stigmosa* (Ludwig)

Plate 17, figs. 10–36

1859 *Potamogeton stigmosus* Ludwig, p. 60, pl. 8, fig. 13, 13*a*, 13*b*.
1957 *Myrtospermum variabile* Chandler, p. 112.
1960 *Cleyera*? *variabilis* (Chandler) Chandler, pp. 213, 229, pl. 31, figs. 48–56; pl. 34, fig. 145.
1960 *Eurya stigmosa* (Ludwig) Mai, p. 79, pl. 4, figs. 8–17.
1961 *Myrtospermum variabile* Chandler: Chandler, pp. 80, 108, 335, pl. 8, figs. 8, 9; pl. 11, fig. 18; pl. 34, figs. 16–18.
1961*b* *Cleyera*? *stigmosa* (Ludwig) Chandler, p. 139, pl. 28, figs. 108–112.

Description. *Seed*: Very variable in form, sculpture and size, bisymmetric, subcircular, subtriangular, subquadrangular or somewhat irregular in outline, more or less inflated, sometimes narrowed towards the large oval hilum which lies in some triangular seeds at one of the angles where it may be marked by a slight truncation, in others, at the middle of one of the sides of the triangle. Limbs of U-shaped cavity of fairly uniform diameter (about 0·3 mm.), but of slightly unequal length; micropylar aperture small, terminal on the longer limb; chalaza subterminal on the inner angle of the shorter limb. Surface deeply foveolate, the pits commonly equiaxial, often about 0·075 mm. in diameter. Sometimes arranged in concentric rows near the margin, or with no clearly defined arrangement. Over the area between the limbs the pits are often smaller, about 0·025 mm. in diameter. Testa in section 0·125 to 0·25 mm. thick, formed externally of a coat which bears the large 'pits' or foveolae oriented either obliquely or perpendicularly to the surface. The outer wall of these foveolae appears formerly to have been inflated and convex to the exterior but is now normally collapsed producing the foveolae. The ridges between them vary somewhat in width according to the degree of collapse. Walls of foveolae reticulate indicating formation from finer parenchymatous tissue the small cells of which are sometimes visible through partial decay of the coat. Inner layers of testa compact, formed of radially aligned equiaxial cells 0·01 to 0·02 mm. in diameter. Cells of seed-cavity equiaxial, arranged transverse to the long axis of the curved seed. Diameter of typical seeds from Sandbanks, 1 by 1·25 mm.; 1·75 by 1·5 mm.; 1·25 by 1·5 mm.; 1·25 by 1·25 mm. From Branksome Dene, 1·5 by 1·5 mm.; 1·25 by 0·8 mm.; 1·5 by 1·25 mm.; 1·1 by 0·75 mm.; 1 by 1 mm. From higher beds there is a similar range of variation. Abortive seeds may be smaller.

Remarks and Affinities. As shown in the synonymy above the correct determination of this seed was long delayed. Dorofeev was the first to recognize the structure as that of Theaceae

and it was only in 1958 that Kolakowsky published Dorofeev's description of the seed under the name *Eurya* cf. *japonica*. Mai (1960) described with good illustrations comparable specimens from German clays at Hasenberges by Wiesa (Oberlausitz) recognizing their identity with material from Salzhausen described by Ludwig (1859) under the name *Potamogeton stigmosus*. Although Ludwig showed the curved seed-cavity his figures are not specifically recognizable but fortunately Mai was able to examine the holotype. Meanwhile in ignorance of the German discoveries Chandler had recorded these seeds from English localities (see synonyms above) under the name *Myrtospermum variabile*. The supposed relationship to Myrtaceae being suggested by the U-shaped cavity, by the position of organs, and of the condyle between the limbs of the U and by the conspicuously foveolate surface. Thanks to P. I. Dorofeev this error was pointed out in 1960 (p. 211) but the information came too late to be included in work on the London Clay Flora which had been for long in the press (Chandler, 1961). On the strength of Mai's work the identity with Ludwig's species must be accepted and under the rules of nomenclature therefore *Myrtospermum variabile* is a nomen nudum and the species henceforward becomes *Eurya* (or *Cleyera*?) *stigmosa* (Ludwig). As related by Chandler in 1960 (p. 211) the limit of variation of the genera and sub-genera of some of the Taonabeae (Theaceae) is not clearly established through lack of a wide range of Recent material for dissection. As, however, *Cleyera* has a definite U-shaped seed it may be helpful temporarily to refer the fossils to this sub-genus as *Eurya* itself appears to have only bent or hook-shaped seeds (so far as they could be examined). Whether *Cleyera* or *Eurya* makes little difference phytogeographically as both occur in warm Asia and America, *Eurya* itself is found in Japan as well as at warmer latitudes in the New World.

The species is one of the most characteristic fossils of English Eocene plant beds. It ranges from the Woolwich and Oldhaven Beds and the London Clay of Nursling through successive strata up to and including the Lower Headon of Hordle. It occurs in the Bournemouth Freshwater Beds as described above including V.43438 from Sandbanks and V.43444–45 from Branksome Dene and the figured material, and again in the Bournemouth Marine Beds at a low level in the Series just east of the East Cliff lift (figured specimens and V.43447, V.43449), in the hard sands and in a Leafy lenticle (figured and V.43452) both in the Marine Series in the cliff base at Southbourne; also in the Lignite above the Boscombe Sands (figured seeds and V.43453, V.43456–58) and in the Highcliff Sands near Mudeford (figured and V.43463–64, V.43466–70). There are already published records in the Hengistbury and Barton Beds (Chandler, 1960) and at Hordle (Chandler, 1961*b*). A seed is here figured from the Bracklesham Beds of Alum Bay, Isle of Wight, where recognizable plants are scarcely known. A probable occurrence in the Woolwich and Reading Beds, together with others in the Oldhaven Beds and in the London Clay of Nursling, were all erroneously named (Chandler, 1961: 80, 108, 335; pl. 8, figs. 8, 9; pl. 11, fig. 18; pl. 34, figs. 16–18). Allied species occur in the Bovey Tracey lignites (Chandler, 1957: 112, 113, pl. 16, figs. 160–174).

Cleyera? *lentiformis* n. sp.

Plate 17, figs. 37–40

1961 *Myrtospermum* sp., Chandler, p. 335, pl. 34, fig. 19.

Diagnosis. See Chandler, 1961 (p. 335): 'Seed approximately lenticular, about 2·5 mm.

in diameter, 1·25 mm. thick. Maximum thickness of testa, 0·4 mm.; surface pits, 0·05 to 0·075 mm. apart, separated by thick ridges.'

HOLOTYPE. V.43471.

DESCRIPTION. *Seed*: Approximately lenticular, margin sharply angled except at the large subcircular hilum where it is slightly truncate. Micropyle small, limbs of the U-shaped cavity unequal, the micropylar limb longer and broader than the other. Chalaza subterminal on the inner angle of the shorter limb. Testa thick, as much as 0·2 mm. near the micropyle, 0·4 mm. at the opposite margin, the outer layers forming an approximately uniform pitted surface the foveolae being about 0·05 to 0·075 mm. apart, separated by thick ridges. As in *Cleyera*? *stigmosa* (p. 108) the foveolae are the collapsed ends of large, elongate, parallel-sided 'cells' about 0·05 mm. long and these are inclined obliquely to the surface in parts of the testa. Again, as in *C.*? *stigmosa*, these 'cells' appear to be built up of true parenchymatous cells about 0·016 mm. in diameter. The U-shaped cavity is not very apparent on the surface from the size or arrangement of the surface foveolae. Equiaxial cells of the inner layers of the testa radially aligned ranging from 0·025 to 0·33 mm. in diameter. In places the outer and inner layers seem to merge into one another. A funicle strand is preserved in the condylar cavity between the limbs of the U. Diameter of seed, 2·5 mm.; thickness, 1·25 mm.

REMARKS. Only one seed seen from the Highcliff Sands, Cliff End, Mudeford, but it and a seed previously described as *Myrtospermum* sp. from the London Clay of Nursling (Chandler, 1961: 335) appear to be identical. The Highcliff Sands seed had begun to split marginally (Pl. 17, fig. 38) and on dissection along the split showed the characteristic structure of the Theaceae, section Taonabeae. These two seeds are larger, much thicker-walled and have a thicker inner part of the testa than in other species described from Hampshire and Dorset or Bovey. They are named *Cleyera*? *lentiformis*.

?*Cleyera* sp.

Plate 17, figs. 41–45; Text-fig. 20

DESCRIPTION. *Seed*: Woody, bisymmetric, sub-obovate, obliquely truncate at the base, almost flat, evidently splitting in the plane of symmetry into two equal valves one of which is preserved. Cavity U-shaped with very slightly curved unequal limbs separated by a clavate condyle as seen on the interior of the valve. Sutures at the margin and over the condyle smoothly finished, marginal suture 0·5 mm. broad in the largest specimen. Hilum marginal between the limbs, micropyle marginal, adjacent to the hilum, terminal on the longer limb. At the proximal end of the condyle arising at the hilum there is a shallow cavity leading into a narrow canal which extends almost to the inner end of the condyle and is slightly curved parallel with the micropylar limb. There is little indication on the external surface of the U-shaped cavity. The surface is rugose but much corroded, the rugosities having a tendency to a radial arrangement around the margin so as to give an obscurely fluted appearance, with ridges about 0·1 mm. apart. Testa formed throughout of equiaxial cells 0·017 mm. in diameter. Dimensions of seeds: 1) Length, 2·8 mm.; breadth, 2·3 mm. 2) Length imperfect; breadth, 1·8 mm.

REMARKS AND AFFINITIES. Two imperfect seeds represented by single valves which show he internal structure. A third seed, represented by a pair of much compressed small valves

broken at the base may also belong to the species, but its internal structure has not been seen. The species is distinguished from others described above by the combination of size, flatness and the finer cells of its testa. It appears to be distinct, but to such limited imperfect material

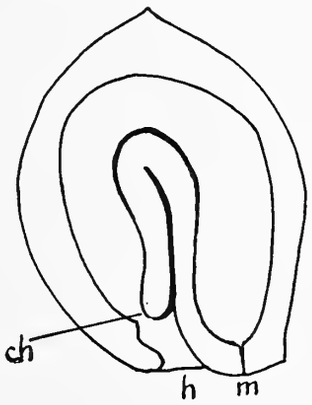


Fig. 20. ?*Cleyera* sp. Inner surface of valve of seed showing curved cavity, limbs separated by condyle; *m*, micropyle; *h*, hilum; *ch*, chalaza.

it seems inadvisable to give a specific name at present. All are from the Highcliff Sands, Cliff End, Mudeford.

Genus?

Plate 18, figs. 1–3

Description. *Seed*: Woody, bisymmetric, sub-oboval in outline but now incomplete at the base, much compressed, splitting into equal valves along the margin. Cavity U-shaped (both limbs incomplete below); condyle between limbs elongate narrowly clavate almost straight with narrow longitudinal median canal. Sutures at the margin and on the condyle smoothly finished, marginal suture about 0·2 mm. broad. External surface almost smooth with slight median elevation over the condyle from which inconspicuous, slightly sinuous, interrupted ridges (0·02 mm. wide) diverge; traces of very obscure radial flutings can be detected near the margin at the rounded end of the seed. Surface cells about 0·016 mm. in diameter. Interior of seed-cavity irregularly striate transverse to the length. Tegmen represented by a fragment only in the proximal end of one limb, smooth, apparently formed of equiaxial cells about 0·012 mm. in diameter Length of seed (incomplete), 3·15 mm.; breadth, 2·1 mm.

Remarks and Affinities. A single incomplete specimen from the Highcliff Sands, Cliff End, Mudeford, represented by two separated valves one much broken, the other broken at the base, the basal truncation bearing no relationship to the shape of the seed-cavity. An examination of specimen or figure (Pl. 18, fig. 2) suggests that the seed must originally have been much longer and narrower in outline. The U-shaped cavity and channelled condyle suggest relationship with Taonabeae of the family Theaceae. The condyle is, however, straighter and more slender than in the seeds referred provisionally to the genus *Cleyera*. No closer determination can at present be made on the evidence of this single imperfect specimen.

Genus?

Plate 18, figs. 4, 5

A species belonging to Taonabeae is represented by an isolated tegmen; testa not preserved. It shows the U-shaped form of the seed-cavity with unequal limbs which must have been separated originally by a long narrow condyle. The micropyle is terminal on the longer limb, the chalaza, an oval opaque scar, subterminal on the shorter limb. The tegmen is translucent, its cell structure obscure except towards the end of the micropylar limb where it is formed of quadrangular cells, 0·025 mm. in diameter, arranged in regular longitudinal rows. The thin remains of an opaque, close-textured coat representing perhaps part of the testa adhere to the micropylar limb. Diameter of tegmen measured parallel to the limbs, 1·4 mm.; diameter across the two limbs, 1·5 mm.

Remarks and Affinities. A U-shaped tegmen from the Highcliff Sands, Cliff End, Mudeford. Without knowledge of the testa it is impossible to make a closer determination. It is approximately the size of the seed-cavity in *Cleyera*? *lentiformis* (p. 109) but may equally well belong to some other genus or species not yet found complete.

Genus HORDWELLIA Chandler, 1960:228

Hordwellia crassisperma (Chandler)

1926 *Actinidia crassisperma* Chandler, p. 34, pl. 6, fig. 2; text-fig. 15.
1960 *Hordwellia crassisperma* (Chandler): Chandler, p. 229, pl. 34, figs. 140–144.
1962 *Hordwellia crassisperma* (Chandler): Chandler, p.112, pl. 17, figs. 8–61.

For details as to character and distribution of this species see reference 1962 above where it is also fully illustrated. Unfigured material from Sandbanks is V.43485–89; V.43490 numerous unfigured seeds from Branksome Dene; V.43491 from Lignite above the Boscombe Sands, Southbourne; V.43492–93 are from the Highcliff Sands, Cliff End, Mudeford.

Family FLACOURTIACEAE

Genus ONCOBA Forsk.

Oncoba rugosa Chandler

Plate 18, fig. 12

1962 *Oncoba rugosa* Chandler, p. 114, pl. 16, figs. 5–10; text-fig. 16.

The species was fully described and illustrated in the above monograph. A Sandbanks specimen was taken as the holotype and one from the Freshwater Beds at Branksome Dene was also figured. In addition there are two seeds from the Highcliff Sands and one from the Dorset Pipe-clay Series at Arne. A broken specimen showing the chalazal scar in section is here figured from the Highcliff Sands. Another fragment (V.43494) from Branksome Dene displays clearly the chalazal scar with rim and central mucro. Other seeds and fragments (V.43496–97) are from the Highcliff Sands.

Family THYMELAEACEAE

Genus THYMELAEASPERMUM Chandler, 1962: 116

Thymelaeaspermum bournense n. sp.

Plate 18, figs. 13–24; Pl. 19, figs. 1–5

Diagnosis. Seed pointed obovoid, but without flattening on one side, obscurely bisymmetric about a plane through raphe. Micropylar end straight or curved. Chalaza with external prominence having a lateral or subterminal aperture for raphe. Inner chalaza often oblique to the axis. Tegmen, hard, thick, formed superficially of raised but flat-topped cells with small central pit. Surface often beset with large depressions occurring singly, grouped or in longitudinal lines. Estimated length of seed about 6 mm.; breadth about 3 mm.

Holotype. V.42238.

Description. *Seed*: Pointed obovoid, anatropous, obscurely bisymmetric usually about a plane through the raphe. The outline of the raphe side of the seed is frequently less convex than the opposite side. Testa thin and membraneous by inference from comparison with living forms but invariably worn away. It is however represented, although rarely, by impressions on the hard coriaceous thick shining tegmen, the coat commonly preserved. One seed shows a coarse network of cells with raised walls, all much worn, and this may represent a layer of the testa, its cells are transversely elongate, about 0·025 to 0·045 mm. broad, and arranged in rather irregular longitudinal rows. Another seed with well preserved but highly polished tegmen shows clear impressions of longitudinally aligned slightly sinuous ridges representing cells arranged in longitudinal rows (Pl. 18, fig. 18). The longitudinal raphe is almost always abraded as it apparently lay within the testa. Its remains are occasionally seen in a shallow depression on the surface near the rounded end of the seed. Micropyle at pointed end which is sometimes curved (Pl. 18, fig. 16). Chalaza at rounded end often indicated by a conspicuous knob, or a hood-like prominence which bears a large subterminal or lateral aperture on the raphe side. The aperture leads obliquely into the seed-cavity where a large circular scar (not always preserved) marks the inner chalaza. Scar sometimes placed obliquely in regard to the axis of the seed. External surface of tegmen exposed in most specimens and as it may be abraded to different degrees its appearance varies. It is formed of equiaxial cells about 0·016 to 0·025 mm. in diameter; usually slightly raised and somewhat flat-topped each with a small dot or pit at the centre as seen superficially. The pits are especially noticeable in the more abraded specimens. The surface often shows large depressions also, at least 0·025 to 0·06 mm. in diameter, scattered thickly and more or less evenly, singly, or in groups of two or three; sometimes twelve or more such depressions are contiguous in a group or a longitudinal line in which case they form a conspicuous feature. Such groups are not invariably present, and may be confined to one part of the surface only; they may be due to collapse of cells walls or to some special condition contingent on maceration and fossilization but may be an original feature. Plate 18, fig. 18 has small and inconspicuous depressions and its surface is unusually well preserved, shining, with the impressions of the testa cells clearly visible. It suggests therefore that the depressions are only clearly seen when the tegmen has undergone

considerable abrasion. The different appearance of this specimen appears to be due to its unworn condition. It is not a distinct species.

The tegmen is about 0·15 mm. thick at the middle of the seed, thinner at the hilar end; it is formed of regularly curved columnar cells, the curvature as seen in longitudinal sections of the seed being convex to the hilar end, and the columns diverge from the chalazal end (Pl. 18, fig. 17; Pl. 19, fig. 2). The curvature is greatest near the inner ends of the columns. Some sections suggest that more than one coat is present in the thickness, the outer layers being formed of simple columns, about 0·016 to 0·025 mm. in diameter and about 0·1 mm. in depth at the middle of the seed, the inner layers of finer columns about 0·007 mm. in diameter and 0·05 mm. in depth. At their junction the two layers dovetail into one another so as to form a continuous wall. The inner surface of the tegmen shows equiaxial cells, also slightly convex, which are the inner ends of the columns but they are often overlain by a rough, partially decayed integument. The tegmen is brittle, consequently perfect seeds are rarely, if ever, preserved in the deposit where all fossil material has been subjected to much maceration, battering and compression. Always one side of the seed has gone so that the precise symmetry is lost. But although there is evidence of an unequal degree of convexity in a longitudinal direction on opposite sides, there is no clear evidence of flattening on one side such as is seen in two-loculed, two-seeded, living genera. Estimated length of seed about 6 mm. (always so far incomplete); breadth, 3 mm. or rather less.

Remarks and Affinities. Among the most abundant and characteristic fossils in the Lignite above the Boscombe Sands, Southbourne (cf. V.42246–47 unfigured), occurring also, but less conspicuously, in the Marine Beds below the Sands and in the Highcliff Sands above (V.42252–53 unfigured). According to the condition of preservation, the appearance varies as described. In the Lignite above the Boscombe Sands the better preserved specimens are compact in texture, dark and shining. The less well preserved show a tendency to crack around the individual cells and so to disintegrate. Frequently the cell walls have been replaced by a soft, dull, amorphous, fine-grained pyrites which readily smears and deteriorates into mud. Specimens in this condition cannot be preserved for long and all seem peculiarly liable to perish.

The seeds from the Highcliff Sands are less complete than those from Southbourne. They show the slight bisymmetry and the hood-like prominence of the outer chalaza with its lateral or subapical aperture for the entry of the raphe (Pl. 19, figs. 3–5). The raphe itself is always abraded, but its position is probably indicated by a slight channelling, and by longitudinal alignment of the cells and resulting striation of the surface immediately below the aperture. The pointed micropylar end is invariably broken in these seeds but the tegmen is hard, well preserved, from 0·1 to 0·15 mm. thick, thickest at the middle and at the chalazal end. The cells are equiaxial superficially, about 0·037 mm. in diameter. The surface also shows fairly uniformly arranged, flat-bottomed depressions about 0·06 mm. in diameter, commonly but not invariably separated by about their own width. Large contiguous groups of these depressions have not so far been seen as in those from Southbourne perhaps because of the less abraded state of the surface in the Highcliff Sands specimens, but some of the seeds can be matched exactly with others from Southbourne, so that they may be presumed to belong to a single species.

The form, arrangement of organs and cell structure indicate Thymelaeaceae. The majority

of genera in the family have a greater degree of symmetry than the fossils both at the chalaza and at the micropyle. Thus at the chalaza the aperture for the entry of the raphe is more symmetrically placed as is the external tumescence and internal scar associated with the chalaza. This symmetry is noticeable in the one-loculed sub-sections and genera. No living seeds so far seen have shown the large solitary or grouped external depressions. A few genera of Thymelaeaceae in the sections Aquilarioideae and Phalerioideae have two-loculed fruits, but as a rule their seeds show a conspicuous flattening of the surface which was in contact with the septum. No hint of such a flattening has yet been seen in the fossils, but the curved micropylar end which is not infrequent can be matched in the Aquilarioideae. The raised but flat-topped cells of the tegmen with very small central pit are closely comparable with those of *Aquilaria*. But in *Aquilaria* the prominence over the chalaza may be extremely long and conspicuous and it is invariably longer and more prominent than in the fossil. It has a marked lateral aperture often on the opposite side to that on which the raphe lies, so that its raphe may pass around over the chalazal projection of the seed before turning into this opening. The opening is situated so that it lies above the more convex side of the seed, not above the flat side while in the fossil the opening may sometimes lie above the less convex of the two sides. The cell structure of the tegmen in *Peddiea* and *Phaleria*, which are also two-loculed with bisymmetric seeds, is unlike that of the fossil.

The greater bisymmetry of the one-loculed Recent seeds so far examined distinguishes them from the fossils which nevertheless somewhat resemble the elongate species of *Daphne*. In *Daphne*, however, the cells of the tegmen are not conspicuously raised superficially and the central pit is much larger forming a very noticeable feature with marked regular arrangement all over the surface.

There do not seen to be sufficient grounds for uniting the fossils with any one Recent genus examined but they appear to be more closely allied to the two-loculed *Aquilaria* than to other forms in spite of characters, as already indicated, which are not in accord with this relationship. As the fruit is unknown there is no evidence whether it was one- or two-loculed.

For the time being therefore the fossil is referred to a form-genus *Thymelaeaspermum* indicating affinity not with *Thymelaea* but with the family Thymelaeaceae. A specific name *T. bournense* has been given for the species appears to be recognizable and is common in the lignites above the Boscombe Sands. A species from the Dorset Pipe-clay at Lake was described as *T. lakense* (Chandler, 1962: 116, pl. 16, figs. 11–15). It is larger, shorter and relatively broader than *T. bournense* and tapers more abruptly to the micropyle. It shows little evidence of large depressions on the surface of tegmen and may represent a different genus although temporarily included in the form-genus *Thymelaeaspermum*.

Thymelaeaspermum sp.?

Two fragments of a seed, possibly referable to Thymelaeaceae. The external surface is much decayed but beneath a thin, obscure, superficial layer the outlines of rounded equiaxial cells, about 0·02 to 0·025 mm. in diameter are seen. In section these cells appear to be equiaxial but aligned so regularly in radial rows as to produce a marked columnar effect, the columns being curved. The inner surface of the tegmen is formed by the ends of these columns, producing, as on the exterior, rounded cells, 0·02 to 0·025 mm. in diameter, which tend to

separate as the result of decay. Tegmen about 0·125 mm. thick. V 42254 from a carbonaceous lenticle (Boscombe Sands?), Southbourne.

Genus DAPHNE Linnaeus

Daphne bournensis n. sp.

Plate 19, figs. 6–8

1960 ?*Daphne* sp., Chandler, p. 213, pl. 31, figs. 46, 47.

DIAGNOSIS. Seed pointed obovoid, chalaza marked by a symmetrical tumescence at the rounded end which is pierced by a terminal opening for the raphe and encloses a small cavity. Tegmen formed superficially of thick-walled equiaxial, slightly convex or flat cells about 0·025 to 0·05 mm. in diameter with very small lumen and without large depressions at the surface, about 0·05 mm. thick, showing in section a curved columnar structure. Length of seeds, 2·5 to 2·75 mm.; diameter, 1·5 to 2 mm.

HOLOTYPE. V.36483.

DESCRIPTION. *Seed*: Pointed obovoid, anatropous, slightly bisymmetric through the raphe, raphe side of seed slightly less convex than the opposite side so that the transverse diameter which passes through the raphe is rather less than the diameter at right angles to it. Raphe and thin testa abraded except for obscure remains. Micropyle terminal at the pointed end. Chalaza at the rounded end marked by a symmetrical tumescence which is pierced by a terminal opening for entry of the raphe and encloses a small cavity. Tegmen thick, hard, shining, brittle. External surface (normally exposed through abrasion) showing thick-walled, equiaxial, flat or slightly convex cells, about 0·025 to 0·05 mm. or rather less in diameter, with small lumen appearing as a pit in the centre of the cell especially where most abraded. The cavities show a marked regularity of spacing and alignment. No scattered large depressions as in *Thymelaeaspermum bournense*. Tegmen in section about 0·05 mm. thick at the middle of the seed somewhat thinner at the micropylar end, formed of regular curved columnar cells the columns being convex towards the micropyle and diverging from the chalazal end of the seed. Columns probably formed of cells piled regularly one on top of the other or they may be of single cells with obliquely striate lateral walls, it is not clear which. They gradually narrow towards the seed-cavity where their ends produce slightly convex cells aligned in longitudinal rows, somewhat smaller than the corresponding cells on the exterior of the coat. Length of seeds, 2·5 to 2·75 mm.; maximum diameter at the middle, 1·6 to 2 mm.; least diameter at the middle (passing through the raphe), 1·5 mm.

REMARKS AND AFFINITIES. Three seeds, originally perfect, from the Lignite above the Boscombe Sands, Southbourne, with a tendency to split at the micropylar end along the line of the raphe. The holotype subsequently broke showing the internal characters. The arrangement of the organs and structure of the tegmen point to Thymelaeaceae. The form, symmetrical opening and protuberance of the chalaza, surface cell structure and the type of curvature of the columnar cells when the wall is seen in longitudinal section indicate *Daphne*. The species is about the same size as *Daphne julia* and *D. gnidium* (length, 3·75 mm.) but the surface cells in these species are on the whole finer than in the fossil. The genus occurs throughout Europe and temperate and subtropical Asia.

A seed described as *Daphne* sp. (Chandler, 1960, see above) found in the Upper Hengistbury Beds closely resembles *D. bournensis* in appearance but its broken condition did not permit of specific description and slight differences were noted and described.

Family LYTHRACEAE

The Lythraceae are represented in Tertiary deposits by several extinct and living genera. Two at least in the London Clay are extinct (Reid & Chandler, 1933: 415–425). Another extinct genus, *Alatospermum* (Chandler, 1962: 119, pl. 16, figs. 20–25; pl. 17, figs. 1–6) and the living *Ammannia* (Houst.) L. (1962: 118, pl. 16, figs. 17–19) occur in the Dorset Pipe-clay Series at Lake. The Recent genus *Decodon* J. F. Gmel. is of common occurrence from the Oligocene upwards in many localities on the Continent too numerous to quote in detail. Kirchheimer gives German and Dutch localities (1957: 152) and Krystofovich (1957, numerous references) and other writers, notably Dorofeev (numerous references) and Nikitin (1957), record a number of Russian finds. Of this genus there are certainly two fossil species. The extinct *Diclidocarya* E. M. Reid comes from the Brown Coal of Senftenberg now regarded by Kirchheimer as Oligocene (1957: 153) and the extinct *Microdiptera* is recorded by Chandler from Bovey Tracey (1957: 107, pl. 15, figs. 133–149; text-fig. 2); Hordle (1961*b*: 141, pl. 29, figs. 116, 117); Colwell (1963: pl. 31, figs. 99-107). In the present work there is a new species of *Microdiptera* from the Bournemouth Freshwater Beds of Sandbanks and Branksome Dene while the Bovey species is found in the Highcliff Sands, Cliff End, Mudeford.

The table below shows the distinctive characters of *Decodon*, *Diclidocarya*, *Alatospermum* and *Microdiptera* which have features in common.

Genus	Form of seed	Character of germination valve	Testa extensions or thickenings
Decodon	Compressed dorsiventrally or laterally or uncompressed and subglobular.	Valve extending for whole length of dorsal surface of seed gaping at hilar end but remaining attached at apex.	Seed body surrounded dorsally and laterally by a corky thickening—very conspicuous in *D. gibbosus* on the dorsal side.
Diclidocarya	Compressed dorsiventrally with greatest diameter in plane of germination valve.	Valve an oval operculum falling completely free and extending only over the lower half of the seed body.	Seed body flanked laterally by pronounced corky thickenings.
Alatospermum	Compressed and very thin dorsiventrally.	Valve extending for whole length of the seed body, gaping at hilar end but remaining attached at apex.	Seed body flanked laterally by two thin wings which may be equally or unequally developed on the two sides.
Microdiptera	Compressed and very thin dorsiventrally.	Valve an oval operculum as in *Diclidocarya* extending only over lower half of seed body.	Seed body flanked laterally by two thin wings usually more or less equally developed.

Genus MICRODIPTERA Chandler, 1957:107

Microdiptera major n. sp.

Plate 19, figs. 9–29; Text-fig. 21

DIAGNOSIS. Seed frequently triangular in outline, seed body elongate oval, lateral wings thin but stiff and filled with spongy tissue, ventral surface of wings only slightly concave or commonly flat. Raphe fusiform, very prominent. Base often stipitate at hilum. Maximum length recorded, 1·9 mm.; minimum length, 1·25 mm. Maximum breadth, 2·75 mm.; minimum breadth, 1·6 mm.

HOLOTYPE. V.42255.

DESCRIPTION. *Fruit*: Multilocular, many-seeded, capsular?, carpels long and narrow. Seeds arranged in numerous overlapping longitudinal rows with the hilum directed towards

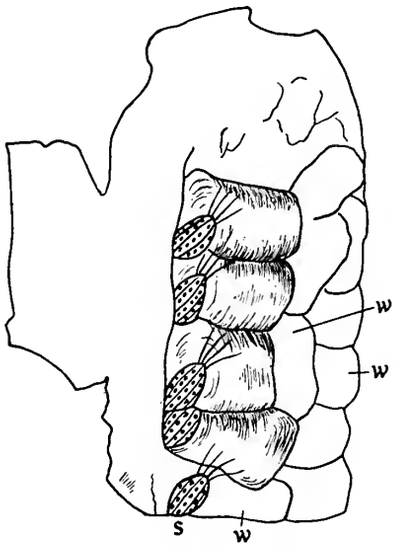


Fig. 21. *Microdiptera major* n.sp. Fragment of fruit with seeds in position of growth to clarify Pl. 19, fig. 16. *s*, seed body; *w*, wings of seeds.

the axis of the fruit as in axile placentation (Pl. 19, fig. 16; Text-fig. 21), possibly borne on thin placentae projecting into the locules. Surface of locule finely striate, striae about 0·005 mm. apart.

Seed: Anatropous, dorsiventrally compressed and thin, frequently broadly triangular, sometimes oval, or irregular in outline, often sharply pointed or stipitate at the marginal hilum, occasionally emarginate at the apex, differentiated into a median elongate oval body and stiff, thick, lateral wings of irregular shape. Dorsal surface somewhat convex, ventral surface more or less flat, or very slightly concave. Raphe a median prominent fusiform ridge extending from base to apex, lying in a longitudinal groove on the ventral face. Germination by an oval completely detachable operculum in the basal half of the dorsal face of the seed body and associated with a basal micropyle. Internal chalaza a clearly defined circular scar at the apex of the seed body. Testa formed superficially on both surfaces of an outer layer of more or

less transversely or obliquely aligned cells which are largest around the operculum and an inner layer (well exposed in abraded seeds) of fine cells swirling around the operculum and around the circumference of the wings. The surface of the operculum is formed of equiaxial cells (0·025 to 0·05 mm. in diameter) aligned regularly in about eight to ten longitudinal rows. The interior of the wing is filled with a spongy tissue of equiaxial cells which evidently constituted a 'float' mechanism. The seed-cavity is surrounded by highly compressed hard tissue, about 0·075 mm. thick, which tends to break with a conchoidal fracture; its cell structure cannot be distinguished. The tegmen is semitranslucent, of elongate cells, 0·012 mm. broad. Length of seed from 1·25 to 1·9 mm.; breadth, 1·6 to 2·75 mm. The following are measurements of a typical range of seeds: 1) Length, 1·65 mm.; breadth, 2·75 mm. 2) Length, 1·5 mm.; breadth, 2·25 mm. 3) Length, 1·75 mm.; breadth, 2·1 mm. 4) Length, 1·25 mm.; breadth, 1·6 mm. 5) Length, 1·9 mm.; breadth, 1·75 mm. 6) Length, 1·75 mm.; breadth, 2·75 mm. The measurements of a series of opercula are as follows: 0·8 by 0·4 mm.; 0·8 by 0·3 mm.; 0·75 by 0·5 mm.; 0·75 by 0·45 mm.

Remarks and Affinities. Numerous seeds from Sandbanks (V.42261 unfigured) and Branksome Dene (V.42270–71 unfigured) and one fragment of carpel crowded with seeds in the position of growth from Branksome Dene. The form of the anatropous seed, position of the organs and corky thickening in the wings of the testa indicate relationship with Lythraceae. The shape of the seeds at once suggested an imbricate arrangement in a fruit with central placentation such as may occur in this family. This deduction was borne out subsequently by the discovery at Branksome Dene of the fruit fragment (Pl. 19, fig. 16). So far as known no living genus shows an exactly comparable operculum. *Decodon* G. F. Gmel. has a valve which gapes at the micropyle but remains attached at the chalazal end. It occupies the whole length of the seed. This valve shows a similar surface pitting to that of the opercula of seeds in *Microdiptera* and the species now described. *Decodon* and other Recent genera have a corky thickening of the testa, but except in *Lagerstroemia*, which has lateral wings, the thickening is disposed either dorsally, circumferentially, or apically, never laterally only. *Lawsonia* Linn. has seeds rather comparable in shape, but has an apical thickening formed of coarse cells, and there appears to be no coat of swirling fibres. The characters of *Microdiptera* suggest the closest alliance with the section Nesaeae, but almost certainly the genus is an extinct one. A comparable operculum, similarly pitted was seen in the extinct *Diclidocarya menzelii* E. M. Reid. Here the seed was somewhat dorsiventrally compressed with a median oval body, flanked laterally by conspicuous thickenings. But *D. menzelii* is quite distinct on account of its inflated form, both surfaces being convex, the spongy tissue forming lateral thickenings rather than stiff and only slightly thickened wings as in *Microdiptera*. *D. menzelii* is figured for comparison in Pl. 20, figs. 1–4.

Microdiptera parva Chandler

Plate 19, figs. 30–35

1957 *Microdiptera parva* Chandler, p. 107, pl. 15, figs. 133–149; text-fig. 2.
1961*b* *Microdiptera parva* Chandler: Chandler, p. 141, pl. 29, figs. 116, 117.

Description. *Seed*: To the characters described in an account of the species from Bovey Tracey may be added that the seed is sometimes mucronate at the median marginal hilum

(Pl. 19, figs. 31, 32). Dimensions of seeds from the Highcliff Sands are: 1) Length, 1·25 mm.; breadth, 1·5 mm. 2) Length, 0·9 mm.; breadth, 1·16 mm. 3) Length, 1·45 mm.; breadth, 2 mm. 4) Length, 1 mm.; breadth, 1·25 mm. 5) Length, 1 mm.; breadth, 1·8 mm.

Remarks. Five seeds from the Highcliff Sands, Cliff End, Mudeford. *M. parva* is clearly distinguished from *M. major* (p. 118) by its smaller size and thinner more slender form. It was abundant at Bovey Tracey but the majority of the Bovey seeds had rather thinner wings than those from the Highcliff Sands, the difference being readily accounted for by the great degree of compression which almost all Bovey seeds have undergone. One seed only has been found in the Lower Headon of Hordle.

Genus PALAEOLYTHRUM Chandler, 1960:233

Palaeolythrum bournense Chandler

Plate 20, figs. 5–21

1960 *Palaeolythrum bournense* Chandler, p. 233, pl. 34, figs. 138, 139.

Description. *Seed*: Subcircular or obovate (tending in fossilization to split at the base so as to appear bifid), bisymmetric and bifacial with one surface somewhat convex, the other flat or concave, having a marginal rim or wing about 0·3 mm. wide (usually lost in fossilization). The rim surrounds a narrower obovate body which reaches the margin of the seed at the apiculate hilar end only. The body (but not the rim) is ornamented on both surfaces with curved longitudinal somewhat irregularly nodular ribs or flanges which converge at the two poles of the seed, at the narrow end towards the hilum and at the broad end towards the chalaza. The chalaza is subterminal on the concave ventral surface of the seed-body which apparently bears a median longitudinal raphe indicated by a conspicuously striate band of fibres. Over the chalaza there is a marked thickening of carbonaceous tissue (seen in one or two worn specimens) but in the majority of seeds the carbonaceous outer coat is completely abraded and the chalaza is visible only as a small deep depression with raised rim about 0·25 mm. in diameter. Surface longitudinally striate, striae formed by equiaxial cells about 0·01 to 0·012 or even 0·016 mm. in diameter of which the longitudinal walls are emphasized giving a finely striate appearance. Between the ridges over the body and on the rim some of the striae are oblique or transverse.

When rim and testa are abraded as in most specimens the tough coat which forms the obovate seed body is exposed. It is markedly apiculate below, truncate or emarginate at the apex the sunk chalaza being a conspicuous subapical feature. The surface of this body is sometimes rough and uneven with longitudinally aligned rugosities (Pl. 20, figs. 11, 12) formed of equiaxial cells, 0·012 mm. to 0·016 mm. in diameter with thickened longitudinal walls giving a fibrous appearance. When, as is commonly the case, abrasion has proceeded further, an inner coat is exposed which is rough and thin, formed of cells with upstanding walls (the torn edges of abraded tissue). The cells may be square or oblong, but are usually transversely elongate and always transversely aligned so as to produce conspicuous transverse striations (Pl. 20, figs. 13, 15). Diameter of these cells about 0·008 by 0·016 to 0·03 mm. Slightly less worn examples show transverse ridges (Pl. 20, fig. 16). When much worn the seed body becomes

semitranslucent. Seed-cavity smooth and glistening, almost chitinous in appearance, formed of square or oblong cells 0·016 to 0·025 mm. in diameter. The body shows a tendency to split marginally at the apex into subsymmetrical valves. Length of a complete seed, 2 to 2·25 mm.; breadth, 2 mm. Length of seed body, 1·2 to 1·75 mm.; breadth, 0·9 to 1·3 mm.

Remarks and Affinities. Numerous specimens from Sandbanks and Branksome Dene and one from the Freshwater Beds between Alum and Middle Chines. The species also occurs in the Marine Beds at Southbourne and the Highcliff Sands at Cliff End, Mudeford. The majority show the inner integument (or inner layers of the testa) only and have no trace of the rim and conspicuously ornamented outer layers. It was only when perfect specimens were found at Branksome Dene together with others showing different degrees of wear and tear that the true nature of the abundant worn 'bodies' could be understood.

Intensive search was made among living families, but for a long time it was not possible to determine the relationship of these fossils which could not be matched exactly among living fruits or seeds. Attempts were made to interpret them as single carpelled fruits such as Cyperaceae (endocarps in utricles) or Gramineae (fruits in glumes) but always the cell structure or arrangement of organs excluded such an ascription. The carpels of *Urtica* were found to have a locule lining with transversely aligned cells but the seeds were orthotropous and markedly asymmetric. The common occurrence of these fossils in fine silt suggestive of stagnant water and their association almost exclusively with a few marsh plants directed further search to Recent genera from such habitats. The form of the seed and the variable distortion noticed in a related species from Pont de Gail, France, originally described by E. M. Reid (1920: 83) as *Carpolithus* sp. 5 suggested further that they were derived from many-seeded fruits with closely packed seeds. In Lythraceae the characters of multiseeded fruits, anatropous seeds with median ventral raphe, conspicuous chalaza, finely striate testa sometimes with outgrowth were found. An examination of the testa structure in the family demonstrated that within the parenchyma forming its main thickness in some instances (*Punica* and species of *Lythrum*) there may be a thin, compact, but tough layer, longitudinally striate internally which can be stripped off after maceration exposing transverse cells closely comparable with those of the seed body in the fossils. In addition their seed-cavities are lined with a thin, shining coat of equiaxial cells. A marginal rim around a seed body is seen in *Diplusodon*. The related seeds from Pont de Gail already mentioned and described hereafter for convenience of reference as *Palaeolythrum gailense* n. sp. so far as present evidence goes lack the conspicuous rim and external ridges of *P. bournense* but resemble *Lythrum hysopifolium* in form in which a small rim only about 0·05 mm. broad is formed by a thin outer covering of the seed, readily removable by maceration. It therefore appears that although no exactly comparable genus or species has yet been found in Lythraceae, the relationship lies with this family. It has been necessary to institute a new generic name *Palaeolythrum* for the Bournemouth and Pont de Gail material. *P. bournense* came from fine, dark, silty, horizontally laminated sandy clays below Simpson's Folly and in the cliff base near Shore Road, Sandbanks, the latter section is no longer exposed. V.42283–84 is unfigured material from these sites and V.42287–88 is from Branksome Dene.

To complete the range of characters of the genus *Palaeolythrum* an emended description of the related species from the Pliocene of Pont de Gail is given below. The recognition of this as a related form marked an important step in the determination of the family connection.

Palaeolythrum gailense n. sp.

Plate 20, figs. 22–29

1920 *Carpolithus* sp. 5, E. M. Reid, p. 83.

DIAGNOSIS. Seed obovoid, less apiculate than *P. bournense*. Chalaza a conspicuous circular thickening often asymmetrically placed. Outer wall of testa (so far as preserved) formed of equiaxial cells aligned in longitudinal rows, inner coat shining, of transversely elongate and aligned cells coarser than in *P. bournense*. Length of seeds, 0·95 to 1·2 mm; breadth, 0·55 to 0·95 mm.

HOLOTYPE. V.42293.

DESCRIPTION. *Seed*: Originally more or less obovoid (now somewhat compressed in fossilization), anatropous, micropyle and hilum at the narrow end indicated by the divergence of cells, chalaza a subcircular thickened scar 0·1 to 0·15 mm. in diameter (usually broken away so as to leave a gap) at or near the broad end, sometimes conspicuously asymmetrically placed (Pl. 20, fig. 24). The testa cells also diverge from the chalaza. Testa (preserved in patches) rough, formed of equiaxial cells with raised walls, about 0·037 mm. in diameter, aligned in longitudinal rows. There is an inner, obscure, light brown layer, often decayed, and within again is a shining semitranslucent coat or integument formed of transversely elongate cells, about 0·01 by 0·05 mm. in diameter, sometimes arranged in longitudinal rows, but sometimes more irregularly, always dovetailing laterally into adjacent cells and producing a transversely striate effect. This coat is usually exposed by abrasion and is by far the most conspicuous in the fossil state. Length of seed, 0·95 to 1·2 mm.; breadth, 0·55 to 0·95 mm. (increased by compression?) [N.B. Owing to a printer's error the measurements of two specimens described by E. M. Reid were given as 8 by 7 mm. instead of 0·8 by 0·7 mm.]

The seven available specimens give the following measurements: 1) Length, 1·1 mm.; breadth, 0·9 mm. 2) Length, 0·95 mm.; breadth, 0·8 mm. 3) Length, 1·2 mm.; breadth (reduced by folding), 0·65 mm. 4) Length, 1 mm.; breadth, 0·75 mm. 5) Length, 1·05 mm.; breadth, 0·75 mm. 6) Length, 1·15 mm.; breadth, 0·95 mm. 7) Length, 0·95 mm.; breadth (reduced by folding), 0·55 mm.

REMARKS. The form, anatomy and cell structure of the integuments preserved suggest Lythraceae. The relationship is discussed in detail on p. 121 under *Palaeolythrum bournense*. The Pont de Gail specimens, now named *Palaeolythrum gailense*, are usually smaller than *P. bournense*, less attenuated and apiculate at the base and probably considerably more inflated in life, while the chalaza in *P. gailense* is frequently displaced asymmetrically by pressure during growth with consequent unequal development of the two sides of the seed. The transverse cells of the glistening coat are much coarser than in *P. bournense*. So far as the evidence goes there is no trace of a wing-like rim or ridges, such evidence as is preserved suggests a uniform surface of longitudinally aligned cells or pits comparable with that seen in *Lythrum hysopifolium* after the removal of the thin, readily detachable epidermal layer.

Family NYSSACEAE

Genus NYSSOIDEA Chandler, 1962:120

Nyssoidea eocenica Chandler

1962 *Nyssoidea eocenica* Chandler, p. 120, pl. 20, figs. 5–21.

The full description of this species is given in the above reference where material from the Dorset Pipe-clay Series at Lake and Arne, the Bournemouth Freshwater Beds between Alum and Durley Chines, between Branksome and Canford Chines and at Sandbanks, also from the Highcliff Sands at Cliff End, Mudeford, was described and figured. An endocarp from the Freshwater Beds was taken as the holotype. In addition to figured material there are other endocarps (V.41959–60) from between Branksome and Canford Chines, some of which show evidence of the internal ridge below the apical germination valve.

Family CORNACEAE

Section MASTIXIOIDEAE

Genus EOMASTIXIA Chandler, 1926:37

Eomastixia rugosa (Zenker)

Plate 20, fig. 30

1962 *Eomastixia rugosa* (Zenker) Chandler, p. 124, pl. 18, figs. 4-41; pl. 19, figs. 1-7. See for earlier references.

The species has already been fully described and illustrated. It remains to add that about fifty specimens are known from the Freshwater Beds. They are mostly much compressed and shrunken as the result of drying. Many of them are small and some are poorly developed. V.40782 includes five complete but clearly immature flattened examples about 7 mm. long. Most of the material was collected by Mrs. Sugden and was sent to the British Museum in 1869 by W. Sullivan. It was obtained from a dark bed near beach level under the East Cliff at Bournemouth, evidently part of the Freshwater strata from the low position in the section; for the Marine Series lies at a higher level. This record of the site is important as it has for many years been hidden by the Undercliff Drive. Conifers and fruits [probably *Protoaltingia*] reported in Sullivan's letter to be associated with these fruits have perished but there were a number of fruits and endocarps of *Mastixicarpum crassum* (p. 124). There were also scattered occurrences at points between Durley and Canford Chines found by Bandulska. In addition to figured material there are V.6377, V.40763 V.40765–66, V.40781, V.42021 Sugden Coll.; V.41966–67 Bandulska Coll. between Branksome and Canford Chines; V.41968 Bandulska Coll. Durley Chine; V.41969, V.42304 Bandulska Coll. between Alum and Durley Chines; decayed endocarps from between Durley and Middle Chines; Sandbanks and some of which precise locality not known; all from the Freshwater Beds. The species is found throughout the Marine Beds (V.42309 east of East Cliff lift; V.42310-11 Honeycomb Chine) and in the carbonaceous and lignitic bands below and above the Boscombe Sands, Southbourne

(V.42305), as well as in the Highcliff Sands, Cliff End, Mudeford (V.42306, V.42308), and from coarse sands, cliff base (V.42307), all unfigured.

Genus MASTIXICARPUM Chandler, 1926:35

Mastixicarpum crassum Chandler

For references see Chandler (1962) where the species is fully described and illustrated. Many of the specimens occurred in association with *Eomastixia rugosa* at the base of the East Cliff (p. 123). V.41983–84 is unfigured material from this site. A much shattered fruit was found between Durley and Middle Chines. In the Marine Beds most specimens are crushed and flattened but even so show in section the single locule and large infold on the valve. V.42314 is unfigured from Honeycomb Chine, V.42312–13 are unfigured specimens from the Lignite above the Boscombe Sands.

Genus MASTIXIA Blume

Mastixia? glandulosa Chandler

Plate 20, figs. 31–39; Text-fig. 22

1961*b* *Mastixia? glandulosa* Chandler, p. 142, pl. 29, figs. 118–121.

The species was based on beautifully complete but extremely perishable endocarps from Hordle (Chandler, 1961*b*) where the relationship to living *Mastixia* and to the extinct *Retino-*

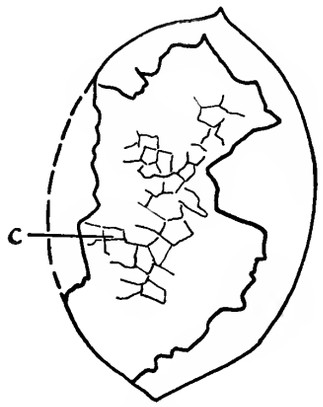


Fig. 22. *Mastixia? glandulosa* Chandler. Endocarp showing manner in which outer layers flake away exposing resin cavities, *c*, in thickness of wall.

mastixia Kirchheimer was discussed. Endocarps occur at horizons from near the base of the Bournemouth Marine Beds, east of the East Cliff lift (V.43017) up to and including the Highcliff Sands, Cliff End, Mudeford (unfigured material, V.43020). Unfigured material comes also from the Marine Beds in a Leafy lenticle, cliff base, Southbourne (V.42318), and from the Lignite above the Boscombe Sands (V.43010, V.43012–16).

All specimens from Southbourne are crushed and are smaller than the Hordle material,

being 5·25 to 8·5 mm. long, 3·5 to 4·5 mm. broad. All from the Highcliff Sands are incomplete but less compressed. The dried resin occurs as oval, angular or elongate rounded fragments, rounded or oval being more abundant in the fragments from the Highcliff Sands, angular and elongate in the Hordle endocarps. As all forms of resin occur at each horizon it is unlikely that any difference of species is indicated.

Section CORNOIDEAE

Genus DUNSTANIA Reid & Chandler, 1933:459

Dunstania glandulosa (Chandler)

Plate 20, figs. 40–46

1961*b* *Dunstania glandulosa* (Chandler) Chandler, p. 144, pl. 29, figs. 125–128.

The species is here recorded for the first time from the Freshwater Beds of Sandbanks where two- to four-loculed specimens were found about 9 mm. long and 5 mm. broad, much compressed, compression enhanced by fossilization so that locules and secreting cavities were all flattened in some instances, V.42024 is an unfigured example. One figured specimen from Branksome Dene had an obscurely longitudinally ribbed exocarp preserved. It had one fertile and one abortive locule when seen in section. Length, 7·75 mm.; breadth, 3·25 by 2·25 mm. A third endocarp, compressed and abraded, found between Durley and Middle Chines, length, 6·1 mm.; breadth, 3·75 by 1·25 mm., was not sectioned. It probably had four locules indicated by longitudinal ridges down each broad face but some at least must have been abortive. There is also one three-loculed endocarp from the Highcliff Sands, Cliff End, Mudeford, length, 6 mm.; breadth, 3·5 mm.

Family CLETHRACEAE

Genus CLETHRA Gronov.

Clethra hantonensis n. sp.

Plate 20, figs. 47, 48

DIAGNOSIS. Seed ovate in outline, convex dorsally, concave ventrally, anatropous with marginal hilum and chalaza. Surface with a network of ridges, the enclosed areoles being finely and evenly punctate. Length of seed about 1 mm.; breadth about 0·9 mm.

HOLOTYPE. V.43028.

DESCRIPTION. *Seed*: Subovate in outline, inflated or convex dorsally, concave ventrally (collapsed, crumpled and much distorted in fossilization), anatropous with marginal hilum and chalaza indicated by knob-like elevations towards which the surface ornamentation converges. Surface with a delicate network of thin, smooth, shining ridges, more raised and conspicuous on the dorsal than on the ventral side, the enclosed areoles being evenly punctate owing to cells from 0·017 to 0·025 mm. in diameter. The meshes of the network are very variable in size and shape, the diameters of individual meshes ranging from 0·1 to 0·2 mm.

Length from hilum to chalaza (as distorted), 1 mm.; breadth of seed at right angles (as distorted), 0·95 mm.; longest diameter of seed (as distorted), 1·2 mm.; shortest diameter, 0·8 mm.

Remarks and Affinities. One seed from the Highcliff Sands, Cliff End, Mudeford, referred to *Clethra*. Its size, shape and especially its ornamentation at first suggested relationship with Ericaceae or Gentianaceae but in spite of a general resemblance no seeds in these families show the exact form of net veining with the beautiful punctate meshes. *Clethra monostachya*, however, has seeds similar in form and identical in surface sculpture. The family Clethraceae is monotypic and was formerly united with the Ericaceae. Its members are trees and shrubs with a scattered range in tropical and subtropical regions. In the Old World they occur in Japan, Java and the Celebes; in the New World in both North and South America. Drude (*in* Engler, 1891: 2) in his account of the geographical distribution of the genus states that it indicates a great age. It has been recorded fossil by Conwentz (1886: 115, pl. 11, figs. 14–20) from flowers in the amber of Königsberg.

Family ERICACEAE

Section ANDROMEDEAE

Genus? sp. 2?

Plate 21, fig. 1

1926 Ericaceae Genus? sp. 2, Chandler, p. 38, pl. 6, fig. 8*a–c*.
1961*b* Ericaceae Genus? sp. 2, Chandler, p. 146, pl. 30, fig. 138.

A small oblate spheroidal syncarpous fruit with five radially arranged locules seated upon a large placenta or receptacle bearing on its lower surface a number of radial ribs or nerves. It appears to be identical with specimens from Hordle referred to an undetermined genus of the Andromedeae. As the internal structure has not been seen the reference to this species can only be provisional. Diameter of fruit, 1 mm. From a Leafy lenticle, Bournemouth Marine Beds, cliff base, Southbourne.

Family EPACRIDACEAE

Genus EPACRIDICARPUM Chandler, 1960:214

Epacridicarpum headonense Chandler

Plate 21, figs. 2–5; Text-fig. 23

1960 *Epacridicarpum headonense* Chandler, p. 234, pl. 34, figs. 146, 147.
1961*b* *Epacridicarpum headonense* Chandler: Chandler, p. 146, pl. 29, figs. 134-137.

Description. *Fruit*: Suboblate spheroidal but with the greatest diameter near the apex, a syncarpous capsule with five radially arranged carpels, apex flat or slightly incurved, base somewhat obtusely pointed, fruit as seen in transverse section scarcely angled; non-stipitate with short stout fibrous axis which is not always preserved. Dehiscence loculicidal, only apparent after maceration due to fossilization, pericarp thick and woody, external surface of concave equiaxial cells, 0·025 to 0·05 mm. in diameter, epidermis shining. Locule lining of

elongate convex cells 0·01 mm. broad, sometimes five or six times as long as broad, often with bevelled ends, over most of the locule surface they diverge obliquely from the subapical placenta but near the inner edges of the septa they are parallel with the axis, at the middle of the locule wall where loculicidal splitting occurs they are parallel with the dorsal margin. Wall in section about 0·1 mm. thick at the equator of the fruit, 0·15 mm. near the base, formed

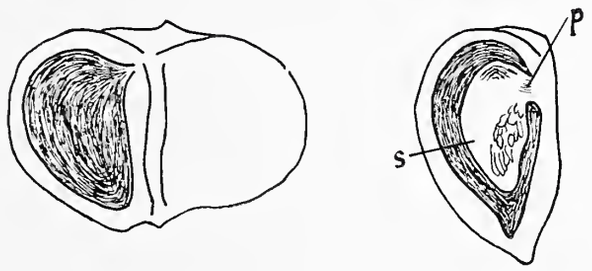


Fig. 23. *Epacridicarpum headonense* Chandler. A, Fruit sectioned longitudinally showing a locule on the left and central axis. B, Single loculicidal carpel showing the shrivelled pendulous seed, *s*; *p*, placenta.

of uniform parenchyma. Locule cavity deeply concave. Length of fruit, 0·65 to 1 mm.; diameter, 1 to 1·15 mm. [N.B. Dimensions were erroneously given as 0·1 to 0·15 mm. in Chandler, 1960: 234.]

Seed: Solitary, pendulous, testa formed superficially of conspicuous cells, about 0·016 mm. in diameter, irregular in shape, the walls of which form a prominent network over the surface.

Remarks and Affinities. Represented by fruits and detached valves which show much variation in size but appear to belong to a single species as other characters are identical. For a discussion of the relationship with reasons for assigning the fossils to Epacridaceae see Chandler (1961*b*). The fruits are identical with a species from Hordle which is also known from the Lower Bartonian (Chandler, 1960). A well-preserved specimen (V.36485) from the Highcliff Sands was chosen as the holotype. Unfigured material from the same locality is V.43030–31.

Epacridicarpum mudense Chandler

Plate 21, figs. 6–8; Text-fig. 24

1960 *Epacridicarpum mudense* Chandler, p. 214, pl. 31, fig. 57.

Description. *Fruit*: Syncarpous, five-carpelled, oblate spheroidal, five-angled, the sides sometimes becoming concave and separated by conspicuous angles in ripe and dehiscing specimens. The angles or ridges overlie the radially arranged locules. A short fibrous axis thickens above the subapical axile placentae to form a flat-topped style or style-base flush with the apex of the fruit. External surface rough with elongate rugosities, coarse pits and depressions tending to form irregular longitudinal striations and ridges. The elongate depressions may sometimes be as much as 0·03 mm. long. Dehiscence by loculicidal splitting. Seeds solitary in the locules, pendulous. Locule lining formed of elongate cells, about 0·075

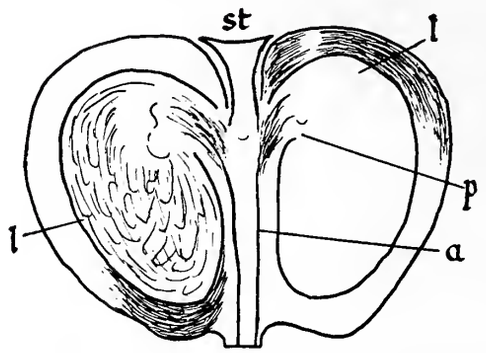


Fig. 24. *Epacridicarpum mudense* Chandler. Fruit broken loculicidally so as to show two locules, *l*; axis, *a*; the flat-topped style, *st*; placenta, *p*.

to 0·1 mm. long and 0·025 mm. broad, diverging from the placentae over the locule surfaces, they lie parallel with the axis near the inner edges of the septa and parallel with the margin of the valves near the dorsal planes of loculicidal dehiscence. Length of fruit, 1 to 1·1 mm.; diameter, 1·2 to 1·45 mm.

Remarks and Affinities. See Chandler (1960: 214). Holotype (V.36486) from the Highcliff Sands, Cliff End, Mudeford. In addition to figured material there is also V.43034 from the same locality.

Genus?

Plate 21, fig. 9

Description. *Fruit*: Syncarpous, five-carpelled, roughly pentangular with deep re-entrant angles alternating with stout fibrous ridges, not depressed at the apex as in Ericaceae; carpels radially arranged around a stout fibrous axis which is continued above in a flat-topped, prominent, five-sided style and below in a longitudinally striate stalk. Dehiscence by loculicidal splitting along the angles. Pericarp thick and woody, rather rough externally with large cells or pits 0·03 to 0·05 mm. in diameter somewhat longitudinally elongate. Locules rather shallow. Cells of the locule lining concave, diverging from the placenta at the inner apical angle of the locule, lying parallel with the margin and axis at the two edges of the split carpels and diagonal over the major part of the surface. Length including style and stalk as preserved, 1·4 mm.; length of fruit without style or stalk, 0·9 mm.; length of style, 0·2 mm. Diameter of half fruit, 0·75 mm., i.e. whole diameter must have been approximately 1·5 mm.

Remarks and Affinities. An imperfect specimen from the Highcliff Sands, Cliff End, Mudeford, showing two locules which have split loculicidally; the axis, stalk and style are well preserved. The ventral margin of the valve is quite straight and the apex shows no depression such as occurs in the fruits of Ericaceae. The small size and loculicidal dehiscence, the form and character of the valves indicate relationship with Ericales; of this group all but Epacridaceae are ruled out either because the stylar end of the fruit is depressed so that the base of the style is sunk, or because there is septicidal dehiscence accompanied by a loculicidal gape along

the ventral margin. It seems clear therefore that the nearer relationship is with Epacridaceae and, although the number of seeds is not known, perhaps with Stypheliae as in the two previously described species.

Genus LEUCOPOGON R. Br.

?*Leucopogon* sp.

Plate 21, figs. 10, 11

DESCRIPTION. *Fruit*: Subglobular, broadly truncate at the base by a circular scar of attachment, having a broad, short, prominent apical style. Surface rough, but enclosed almost to the apex by five accrescent sepals with smoothly rounded free ends, also having one free bract which arises from the truncate base and reaches to the top of the sepals. Sepals apparently thick, surface smooth formed of polygonal cells 0·016 mm. in diameter. Surface of bract almost smooth, longitudinally striate in the middle, the striae formed by polygonal cells about 0·025 mm. in diameter. Towards the top (partly broken) and the margin the striae diverge obliquely so as to lie as much as 0·05 mm. apart. Length of fruit (distorted) including style, 1·15 mm.; length from margin of attachment area to top of style, 0·9 mm.; breadth (crushed), 1·05 mm.; breadth of basal truncation (distorted), 0·6 mm.

REMARKS AND AFFINITIES. One specimen from the Highcliff Sands, Cliff End, Mudeford, distorted by compression but otherwise perfect (unless a bract is missing?). The characters are closely comparable with those of certain Epacridaceae, whilst the accrescent five-partite calyx and the persistent bract arising immediately below the sepals suggest relationship with *Leucopogon*, a genus ranging through Malaya and Australia. Without knowledge of the internal structure and seeds the determination must be regarded as very doubtful.

Family SYMPLOCACEAE

Genus SYMPLOCOS Jacquin

Symplocos headonensis Chandler

Plate 21, figs. 12 (? 13, 14); Text-fig. 25

1961*b* *Symplocos headonensis* Chandler: Chandler, p. 148, pl. 30, figs. 139, 140. (Earlier references given.)
1962 *Symplocos headonensis* Chandler: Chandler, p. 135, pl. 21, figs. 19, ?20.

DESCRIPTION. *Endocarp*: Three-loculed otherwise in general features as already described elsewhere. The single specimen from the Freshwater Beds, Sandbanks, has a much cracked and decayed exocarp formed of black, shining cells (secreting?) 0·012 to 0·016 mm. in diameter, covered in part by a thin black epidermis of irregular slightly convex cells about 0·025 mm. in diameter. The endocarp is compact and woody, about 0·1 to 0·4 mm. thick, the cells are more or less radially aligned with obscure outlines. The locule lining is of elongate cells longitudinally aligned but with transverse or oblique striations, about 0·016 mm. apart, which in places produce a criss-cross effect. The median planes of weakness in the septa meeting at the centre to form a canal are very clearly shown. Seeds pendulous in the several-seeded locules. Diameter of endocarp, 5.5 mm.

Seed: Elongate, variable in shape, rounded at the chalazal end, narrowed to the hilar end. Surface of testa with irregular, slightly sinuous, longitudinally aligned cells about 0·4 to 0·5 mm. broad. Length of seeds, 2·75 to 4 mm.; breadth, 1·5 mm.

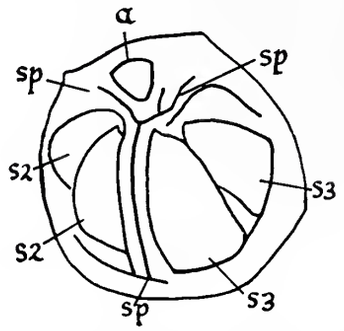


Fig. 25. *Symplocos headonensis* Chandler. Diagram of endocarp to elucidate Pl. 21, fig. 13. *a*, aperture of locule 1; *sp*, septa; *s2*, seeds in second locule; *s3*, seeds in third locule, exposed in both cases by fracture of dorsal wall of endocarp.

Remarks and Affinities. The species is based on material from Hordle (Chandler, 1926; 1961*b*). The Sandbanks fruit is now broken but the fracture showed clearly the three locules and seeds. One locule was abortive and enclosed only a much flattened, immature seed. In the other locules some but not all of the seeds were peculiarly thickened especially on the dorsal side where the testa was 0·2 to 0·3 mm. thick, the testa being columnar in section and formed of two or three layers of cells (? diseased). A three-loculed endocarp was also found in the Dorset Pipe-clay Series at Arne (Chandler, 1962). A small cracked and distorted endocarp (Pl. 21, figs. 13, 14) about 2·5 mm. in diameter from the Lignite above the Boscombe Sands is referred tentatively to the species in spite of its small size. It is four-loculed with transversely striate locule lining, the striae about 0·012 mm. apart, partly obscured by impressions of the testa cells. Seeds with testa as described above. The species was probably present also in the Upper Hengistbury Beds (Chandler, 1960: 215, pl. 31, figs. 58, 59) and in the Bovey Tracey Lignite (Chandler, 1957: 117, pl. 17, figs. 187, 188).

Symplocos sp.

Plate 21, figs. 15, 16

Description. *Endocarp*: Syncarpous, truncate ovoid, three-loculed one sometimes abortive. Much compressed so that it is difficult to be sure of their internal arrangements. At the apex the locules open into a wide apical depression which causes the truncation, sides narrowed to the rounded base. The much worn and crushed surface has obscure longitudinal but irregular ridges. It shows fine pits 0·008 to 0·012 mm. in diameter. The cells of the locule lining are transversely arranged but are much decayed and are not easy to measure. Length of endocarp varies from 5 to 6·25 mm.; breadth from 3·5 to 4·25 mm.

Remarks. Two specimens from the Lignite above the Boscombe Sands, Southbourne. In view of the crushed and poorly preserved condition of this material it is not possible to

determine it specifically with absolute certainty. It closely resembles *S. anglica* common in the Bovey lignites (Chandler, 1957: 116, pl. 17, figs. 181–186).

Family SYMPLOCACEAE? (or CORNACEAE?)

Genus?

Plate 21, figs. 17, 18

A circular plug or perianth disc from an inferior fruit, lenticular in section, inner face slightly concave with smooth, clearly defined, ventral circular scar occupying about two-thirds of the diameter, surrounded by a second concentric smooth area formed of equiaxial cells which project unevenly at the margin giving a fringed effect. Outer face convex with a central projection (style base?) from which coarse cells diverge to the circumference. Plug at least six cells thick. Diameter, 0·87 mm. The specimens from the Highcliff Sands, Cliff End, Mudeford, resemble a plug described and figured from the Dorset Pipe-clay Series at Lake (Chandler, 1962: 137, pl. 21, fig. 23) but are considerably smaller. Unfigured specimen V.43040.

Family OLEACEAE

Genus OLEA (Tourn.) L.

?***Olea headonensis*** Chandler

Plate 21, figs. 19, 20

1926 Oleaceae Genus?, Chandler, p. 42, pl. 7, fig. 7; text-fig. 27.
1961*b* *Olea headonensis* Chandler, p. 149, pl. 30, figs. 141–143.

Description. *Endocarp*: Woody, two-loculed, broadly oval or almost subcircular in outline, bisymmetric, much compressed, with attachment at one end giving access to a longitudinal canal which passes within the septum to the apex. Locules unequally developed so that the septum which connects the two broad faces of the endocarp is asymmetrically, not medianly, situated at right angles to them. Dehiscence by a marginal suture into two equal valves; placentation obscure, but apparently subapical and axile. Locules probably one-seeded. Walls woody, fine-grained, formed of equiaxial cells about 0·012 to 0·025 mm. in diameter except immediately around the locules where they are finer and flattened parallel with the locule surfaces. Thickness of walls on the marginal suture 0·9 mm.; at the middle of the broad faces 0·5 mm. Locule lining formed, in part at least, of elongate transversely aligned cells often 0·1 by 0·03 mm. in diameter. There is also some evidence of fine transverse striae. Length of endocarp, 5·5 mm.; breadth as increased by crushing in fossilization, 5 mm.; thickness, also compressed, 1·3 mm.

Seed: Represented only by shrivelled remains of testa on which cells with walls appearing as double lines can be seen. These measure about 0·03 to 0·05 mm. in diameter. There is also an integument of small equiaxial cells about 0·008 to 0·012 mm. in diameter, so arranged as to produce longitudinal striations in places. These are coarsest near the upper end of the locule (?placental-hilar region).

Remarks and Affinities. An endocarp from Sandbanks split into its component valves which are now fractured. The arrangement of the two locules, one of which is abortive, and of the fibrovascular canal in the septum points to relationship with Oleaceae. Similar double-walled cells are seen in the testa of *Olea*. Endocarps somewhat comparable in form and structure as in size were found at Hordle (Chandler, 1961*b*) and described as *O. headonensis*. In the absence of better preserved material the identity with this Hordle species, although highly probable, must be regarded as provisional.

Family BORAGINACEAE

?Section EHRETIOIDEAE

Genus?

Plate 21, figs. 21, 22

Description. *Endocarp*: Broadly oval in outline, divided by median dorsal and ventral grooves into two equal lobes each broader than a semicircle, each segment or lobe convex dorsally, slightly concave ventrally with indications of a marginal suture for each carpel on this surface. Dorsal surface of each segment ornamented with about thirteen conspicuous pits, ventral surface rather rough (? as the result of decay), dorsal wall 0·041 mm. thick formed of parenchyma, the cells about 0·016 mm. in diameter; ventral wall of similar cells 0·012 mm. in diameter, also showing a few indications of longitudinal striations. Length of endocarp, 1·25 mm.; greatest breadth, 2 mm.; thickness, 0·75 mm.

Remarks and Affinities. One specimen from the Highcliff Sands, Cliff End, Mudeford. The form, sculpture and substance suggest Boraginaceae, section Ehretioideae, in which some fruits have two-lobed pyrenes, but none of comparable shape have been seen.

Family SOLANACEAE

Genus SOLANISPERMUM Chandler, 1957:118

Solanispermum reniforme Chandler

1957 *Solanispermum reniforme* Chandler, p. 118, pl. 17, figs. 189–191.
1962 *Solanispermum reniforme* Chandler: Chandler, p. 142, pl. 22, figs. 14-22.

The seeds were fully described in the references given above and their relationship discussed. A Bovey specimen in the Geological Survey collection was taken as the holotype and other seeds from Sandbanks, Branksome Dene, Southbourne and Cliff End, Mudeford, which show important characters were catalogued and figured (Chandler, 1962). Additional unfigured material is V.43044 from Branksome Dene, V.43043 from Sandbanks and V.43045 from the Lignite above the Boscombe Sands, Southbourne.

Family CAPRIFOLIACEAE

Genus SAMBUCUS (Tourn.) L.

Sambucus mudensis n. sp.

Plate 21, figs. 23–26

DIAGNOSIS. Surface of seed coarsely rugose with about nine interrupted nodular transverse ridges, coarser than *S. parvula* from Hordle. Length of seed about 1·25 to 2·25 mm.; breadth about 1·5 to 1·75 mm.

HOLOTYPE. V.43046.

DESCRIPTION. *Seed*: Obovate, flattened with a small organ at the pointed end. Surface coarsely rugose owing to nodular interrupted transverse ridges about nine in number, also finely and evenly pitted with pits or cells about 0·02 mm. in diameter. Testa thin, hard, about 0·02 mm. thick. Internal surface of testa longitudinally striate, striae 0·014 to 0·017 mm. apart. Length of seed, 1·25 to 2·25 mm.; breadth, 1·5 to 1·75 mm.

REMARKS. Four seeds from the Highcliff Sands, Cliff End, Mudeford, one perfect, the others broken in varying degree, referable to *Sambucus*. Seeds of *Sambucus* have been previously recorded in various Tertiary deposits. They are abundant in the Upper Eocene of Hordle but the Cliff End species is considerably larger than *S. parvula* (length, 1·1 to 1·5 mm.; breadth, 0·6 to 1 mm.) and has coarser rugosities. The broken seed in Pl. 21, fig. 26 is more pointed at the hilar end and has somewhat finer and less conspicuous rugosities. It has a peculiar truncation at the pointed end along one margin.

Genus ABELIA R. Brown

?*Abelia* sp.

Plate 21, fig. 29

DESCRIPTION. *Fruit*: Three-winged, wings oval, broad with several longitudinal nerves which occasionally bifurcate near the proximal end of the wings. The wings arise beneath or from the margins of a central triangular disc, the sharp angles of which alternate with them; a small median triangular scar can be seen at the middle of the disc. No fruit body visible. Length of wings imperfect; breadth, 3·5 and 4 mm.

REMARKS. An impression with broken wing-tips from the Freshwater Beds between Alum and Durley Chines, Bournemouth. The specimen recalls *Abelia* and has been interpreted by reference to that genus, but in the absence of more complete evidence the relationship must be regarded as doubtful.

Family CUCURBITACEAE

Genus CUCURBITOSPERMUM Chesters, 1957:57

Cucurbitospermum mudense n. sp.

Plate 21, figs. 27, 28

DIAGNOSIS. Seed suboval, pointed at both ends, obscurely flanged around the margin especially at the hilar end. Length of seed about 4·3 mm.; breadth about 2·3 mm.

HOLOTYPE. V.43051.

DESCRIPTION. *Seed*: Suboval, pointed at both ends, much compressed, bisymmetric, obscurely flanged on both margins at one end, the flange being more evident internally than externally; germination by marginal splitting in the plane of symmetry into equal valves; width of suture 0·25 mm. at the widest part of the flange, about 0·1 mm. near the middle of the seed. Seed-cavity oval, narrowing gradually at the flanged end into the micropylar canal; raphe and hilar opening obscure owing to the much abraded and distorted condition of the marginal suture along which they lie. Chalaza completely obscured by abrasion, but evidently, from the form of the seed, at the pointed end remote from the micropyle. Testa thin, of two coats, an outer coat (preserved only in a few patches) which appears to have been soft, shining and crumpled, and formed of oblong cells with finely-toothed margins, variable in size but often about 0·025 mm. broad; these cells have a longitudinal alignment except over the flange where they diverge from the more inflated central area of the seed. The inner coat is hard, formed of equiaxial cells, 0·017 mm. in diameter, which in sections of the testa have a columnar arrangement. Length of seed, 4·3 mm.; breadth, 2·3 mm.

REMARKS AND AFFINITIES. One valve of a seed, somewhat distorted and abraded, from Cliff End, Mudeford. Although hilum, raphe and chalaza are not clear, the form of the seed, arrangement of micropyle and detailed structure of testa indicate relationship with Cucurbitaceae. In its outline it resembles *Ecballium* and *Bryonia* but is less inflated and has a somewhat more clearly differentiated central area than in those seeds. As it has not been possible to assign it to a living genus it has been placed in the form-genus *Cucurbitospermum*, but the outline of the seed, pointed at both ends, distinguishes it clearly from all the London Clay Cucurbitaceae (Chandler, 1961: 295–298, pl. 29, figs. 24–31) and from *C. lakense* Chandler (1962) from the Dorset Pipe-clay Series of Lake. A specific name has therefore been given.

INCERTAE SEDIS

Genus RHAMNOSPERMUM Chandler, 1925:30

Rhamnospermum bilobatum Chandler

1962 *Rhamnospermum bilobatum* Chandler: Chandler, p. 146, pl. 23, figs. 18–38; pl. 24, figs. 1–9, see also for earlier references.

The species has been fully described by Chandler (1962) when seeds from successive horizons were figured. In addition to the figured material there are the following: V.43052 from Sandbanks; V.43053 from below Simpson's Folly, Sandbanks; V.43054 from Branksome

Dene; V.43055 from laminated beds at the cliff base behind the broken promenade between Alum Chine and Branksome Dene; V.43056 from between Middle and Durley Chines; all the above in the Freshwater Beds. The following are from the Bournemouth Marine Beds: V.43057 just east of the East Cliff lift; V.43058 from marine hard sands, cliff base, Southbourne; V.43059 from a Leafy lenticle in marine sands, cliff base, Southbourne. V.43060 from carbonaceous beds, base of the Boscombe Sands, Southbourne; V.43061 from Lignite above the Boscombe Sands, Southbourne. V.43062 from the Highcliff Sands, Cliff End, Mudeford. At many of these localities the specimens are so abraded and battered that only the inner shining coat remains. They are commonly also much compressed. At Sandbanks the specimens appear to be relatively unworn, rather abnormally large and to have been ovoid rather than globular although now flattened in fossilization. The surface cells of these specimens tend to be somewhat larger than in those from the other localities. (0·025 to 0·03 mm. in diameter). The 'seeds' commonly measure 2·5 to 3·1 mm. in length, 2·1 to 2·75 mm. in breadth. Their occurrence in the Hengistbury and Barton Beds is recorded by Chandler (1960) and at Hordle by Chandler (1925, 1926, 1961*b*).

Genus DICOTYLOPHYLLUM Saporta emend. Bandulska, 1923:244

Dicotylophyllum pinnatifidum Reid & Chandler

Plate 23, figs. 40–42

1926 *Dicotylophyllum pinnatifidum* Reid & Chandler, p. 151, pl. 10, figs. 8–12.

Description. Two small fragments, one now decayed, have been referred to *Dicotylophyllum pinnatifidum* abundant in the Bembridge Beds. Each showed three lobes of a linear pinnatifid leaf, thick and leathery in texture. The upper surface is rough and crumpled, the lower also very rough. The margin of each lobe is entire, but recurved onto the lower surface. There is a thick, stout, midrib which gives off a secondary nerve to each lobe actually directed to the apex of the lobe but appearing, owing to the recurvature, to pass to the middle of the oblique proximal margin. Length of surviving fragment (V.43603), 3.25 mm.; breadth, 3 mm. The relationship of this species is still undiscovered. Both from the Highcliff Sands, Cliff End, Mudeford.

Genus WESSEXIA nov.

Diagnosis. Syncarpous, two- to six-carpelled fruits with free persistent sepals, seated on a conical receptacle, splitting loculicidally. Endocarp woody, fibrous. Seeds embedded in cavities among the fibres.

Type Species. *Wessexia fibrosa* (Chandler)

Wessexia fibrosa (Chandler)

Plate 21, figs. 30–40; Pl. 22, figs. 1, 2

1926 *Carpolithus* sp. 7, Chandler, p. 46, pl. 8, fig. 5*a*, *b*; text-fig. 30.
1961*b* *Carpolithus fibrosus* Chandler, p. 152.

Diagnosis. Fruit syncarpous, two- to six-carpelled, with free persistent sepals, seated on a low conical receptacle, obovoid or ovoid, splitting loculicidally. Endocarp thick and woody,

formed of stout longitudinal fibres. Length of fruit, 4·25 to 6 mm.; breadth, 3·25 to 4·5 mm. Seeds linear, anatropous, about 2 to 3 mm. long with hyaline integuments.

HOLOTYPE. V.20108.

REMARKS. The species was redescribed in 1961*b* and it is more fully illustrated in the present work for comparison with another species, *Wessexia bournensis*, from Bournemouth. A generic name has now been given until such time as the true relationship is discovered. A single specimen (Pl. 21, figs. 38–40) was found at Sandbanks. It is a four-carpelled fruit, broken at the base, 5·5 mm. long, 2·75 mm. broad. The exocarp is 0·025 mm. thick. There is also a fruit, probably belonging to this species, from the Highcliff Sands, Cliff End, Mudeford (Pl. 22, figs. 1, 2). Its external surface is much abraded exposing inflated shining, ?secreting cells, some elongate and longitudinally aligned, others equiaxial, 0·016 mm. in diameter, others arranged in stellate groups. Length of this fruit, 2·56 mm.; breadth (incomplete), 1·6 mm. Seeds (one preserved) apparently pendulous from the apex. This seed shows three sets of striae at different levels within the testa: 1) due to elongate cells with raised longitudinal walls forming striae 0·016 mm. apart. Remote from the hilar end these cells become shorter and contorted ultimately forming a coarse network. 2) Finer longitudinal striae 0·008 mm. apart. 3) Short, transverse, striae 0·014 mm. apart. Within is a tegmen either transversely crumpled or possibly formed of obscurely seen transversely aligned cells. So far as can be established from such imperfect and limited material it appears on microscopic examination to belong to *Wessexia fibrosa*.

Wessexia bournensis n. sp.

Plate 22, figs. 3, 4

DIAGNOSIS. Fruit obovoid, somewhat flattened at the apex. Exocarp 0·3 mm. thick, coarse-celled, the cells full of a shining secretion. Endocarp lobed, 0·1 mm. thick at the middle of the dorsal wall, thinner below, formed of fine compact longitudinally aligned fibres. Length of fruit, 5 mm.; breadth, 4·5 mm. Seeds numerous in each locule, sunk in pockets in the fibrous wall.

HOLOTYPE. V.43527.

DESCRIPTION. *Fruit*: Woody, obovoid, somewhat flattened at the apex, syncarpous, five-carpelled, five-loculed, splitting loculicidally, the carpels seated on a small basal receptacle. Surface rough (but much obscured by sand). Exocarp, 0·3 mm. thick, coarse-textured, formed of cells with shining black secretions; endocarp lobed, 0·1 mm. thick at the middle of the dorsal wall, 0·06 mm. thick towards the base, light brown, woody, formed of fine compact fibres, longitudinally aligned, so that the surfaces of the septa are longitudinally striate. Seeds pendulous, numerous in each locule, sunk in pockets in the fibrous carpel wall. Length of fruit, 5 mm.; breadth, 4·5 mm.

Seed: Linear, anatropous with marginal raphe, surface formed of small equiaxial cells, 0·025 mm. in diameter, aligned in longitudinal rows. Tegmen shining, light brown, translucent, formed of longitudinally elongate cells giving rise to longitudinal striations.

REMARKS. Two broken fruits (V.43528 unfigured and shredded longitudinally) from the Bournemouth Freshwater Beds, precise locality not given.

Carpolithus apocyniformis Chandler

Plate 22, figs. 5–15

1961*b* *Carpolithus apocyniformis* Chandler, p. 153, pl. 30, figs. 147, 148.

Specimens from Hordle were described by Chandler in 1961*b* (see above).

Abundant specimens from the Lignite above the Boscombe Sands, Southbourne, showed the variation of size to be somewhat greater than the figures given in 1961*b* thus the length of the valves may range from 4 to 11·5 mm. The finely striate shining locule lining is only rarely preserved. The striae diverge obliquely from the remains of the septum at the apex and curve so as to lie longitudinally throughout most of the length of the valve. They are about 0·001 mm. apart and are formed by the thickened lateral walls of small equiaxial rectangular cells. The external surface of the valve is coarsely furrowed and longitudinally striate, formed of equiaxial cells about 0·012 mm. broad above, to 0·025 mm. broad lower down. These cells which are also rectangular are arranged in rather clearly defined longitudinal rows. Sections of a valve showed coarse equiaxial cells, usually shining and vitrified, about 0·02 mm. in diameter. The structure in section differs conspicuously from the section of a *Gordonia* valve from Hordle which is more compact and close-textured. Also the furrows and cells of the dorsal surface distinguish these specimens from the smooth-surfaced valves of *Gordonia*.

Some typical measurements of valves from Southbourne are as follows: 1) Length, 6 mm.; breadth, 2·25 mm. 2) Length, 6·25 mm.; breadth, 3 mm. 3) Length, 5 mm.; breadth, 2·5 mm. 4) Length, 11·5 mm.; breadth, 2·5 mm. 5) Length, 4 mm.; breadth, 2 mm.

Although one of the most characteristic fossils in the Lignite above the Boscombe Sands it has not yet been possible to determine this readily recognizable species. In addition to figured material some of which has now decayed there are numerous detached valves (V.43532).

Carpolithus ornatus n. sp.

Plate 22, figs. 16, 17

Diagnosis. Seed originally ellipsoidal ornamented with transversely elongate hexagonal pits about 0·2 to 0·3 mm. broad. Length of seed, 0·93 mm.; breadth, 0·75 mm.

Holotype. V.43534.

Description. *Seed*: Broadly oval in outline, now flattened, originally inflated, rounded and obscurely apiculate at both ends; conspicuously ornamented with very regular longitudinal rows of hexagonal pits of which the ratio of length to breadth varies from one-third to one-half, the longest axis being transverse; seven longitudinal rows of pits are seen on one of the now flattened faces, these rows converge to the terminal apiculations which therefore probably indicate the positions of hilum and chalaza in an anatropous seed. There is no marked differentiation in the pitting such as would indicate a raphe, unless a slightly crested appearance of the cells along one margin can be so regarded. The pits measure about 0·1 by 0·2 to 0·3 mm. The surface cells are obscure and perhaps very small unless the pits themselves represent cells as is suggested by the way the line of fracture in a broken specimen follows the intervening ridges. The testa is two cells thick, some of the cells on parts of the inner surface being 0·016 mm. in diameter. The lining of the seed-cavity is formed of equiaxial cells 0·012 mm. in diameter. Length of seed, 0·93 mm.; breadth, 0·75 mm.

Remarks and Affinities. One complete but crushed seed and an unfigured fragment (V.43535) both from the Highcliff Sands, Cliff End, Mudeford. It has not been possible so far to discover the relationship of this beautiful seed.

Carpolithus echinatus n. sp.

Plate 22, figs. 18–22

Diagnosis. Small spiny, pitted seeds about 0·9 mm. long with the spines arranged at the angles of the pits.

Holotype. V.43536.

Description. *Seed*: Small, obovoid, with deeply pitted and spiny surfaces. Many of the pits are about 0·05 mm. in diameter, quadrangular, hexagonal or polygonal, the spines arise as irregularities on the ridges between the pits, usually at their angles, so that hexagonal pits may show six spines, quadrangular pits four. There is normally a marked longitudinal alignment of these pits and spines over the whole surface. The external pits correspond with obscure internal convexities 0·05 to 0·1 mm. in diameter. The wall is thin and compact. No organs have been seen, but the diminution in size and convergence of the pits towards the point at one end suggest a hilum or micropyle. No comparable living material has yet been traced and the smallness of the seeds makes comparison extremely difficult. The problem of relationship must therefore remain unsolved for the present. Length of seed, 0·9 mm.; breadth, 0·65 mm.

Carpolithus spinossissimus n. sp.

Plate 22, figs. 23–35; Text-fig. 26

Diagnosis. Small spiny, pitted seeds about 0·8 to 0·95 mm. long with flattened spines arising from the transverse walls between the pits.

Holotype. V.43541.

Description. *Seed*: Small, ovoid or obovoid, with deeply pitted and conspicuously tubercled surface. Anatropous by inference (raphe not seen). Pits usually hexagonal, about 0·05 mm. in diameter, diminishing in size towards the ends of the seed, the transverse walls being produced into compressed bilateral tubercles curved towards one end of the seed. A fractured specimen also shows the following characters. The testa is about 0·05 mm. thick and is built up apparently of fine cells only about 0·005 mm. in diameter, but the external pits form convexities on the internal surface and the testa fractures regularly along the middle of the ridges which separate the pits. Within is a whitish translucent tegmen with angular cells or crumples often 0·05 by 0·1 mm. in diameter at the equator of the seed. At one end, usually the broader (and that towards which the external tubercles are mainly directed), is a circular plug or scar associated with the tegmen, closing a small aperture in the testa (Text-fig. 26). At the opposite end is a very small thickened scar (chalaza) from which the cells of the tegmen diverge; over this latter area, the pits of the testa are small. The plug has a small central external mucro. Dimensions of seeds: 1) Length, 0·95 mm.; breadth, 0·69 mm. 2) Length, 1 mm.; breadth, 0·8 mm. 3) Length, 0·8 mm.; breadth, 0·35 mm. 4) Length, 0·8 mm.; breadth, 0·7 mm. 5) Length, 0·8 mm.; breadth, 0·8 mm.

Remarks and Affinities. The seeds were found in the Freshwater Beds at Sandbanks (V.43546 unfigured) and Branksome Dene. They bear a strong superficial resemblance to *Carpolithus echinatus* from Cliff End, Mudeford. The two species agree in size and in the external pitted surface, also in the correspondence of these pits with convexities on the

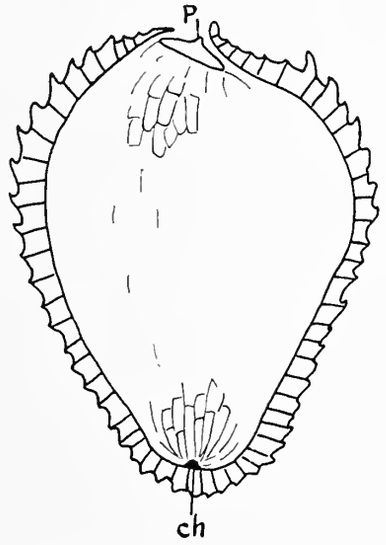


Fig. 26. *Carpolithus spinossissimus* n.sp. Longitudinal section through seed showing plug, *p*, closing cavity (hilum or micropyle); *ch*, chalaza.

inner surface of the testa. *C. echinatus* differs from the species here described as *C. spinossissimus* in the form and arrangement of the external tubercles. In the latter the tubercles are flattened and transversely aligned arising from the transverse walls of the pits so as to give a distinct transverse alignment to the surface ornamentation. In *C. echinatus* the tubercles are usually uncompressed and isodiametric, they arise from the angles of the pits and the alignment of the surface ornamentation is on the whole longitudinal. The two must therefore be regarded as distinct especially as *C. spinossissimus* is known from two localities and shows constant characters in the specimens from both. Possibly both species belong to allied genera.

Carpolithus arnensis Chandler

Plate 22, figs. 36, 37

1962 *Carpolithus arnensis* Chandler, p. 147, pl. 24, figs. 10–13.

Description. *Fruit*: One-loculed, one-seeded, subglobular originally but the upper half missing and the lower now cracked and spreading so as to give an increased diameter of about 55 mm. It finally broke into many fragments. The lower part shows an external circular scar from which longitudinal fibres diverge along the sides lying in conspicuous furrows (Pl. 22, fig. 36). On the inner surface there is an area corresponding to the external scar from which also fibres diverge but they are closer to one another than those of the external surface and quickly die out upwards. Near the broken edges which appear to correspond approximately

with the equator of the fruit the wall thins suddenly producing a marked equatorial line internally (? limits of a large chalaza). Cells of internal surface adjacent to this line are transversely aligned, elsewhere the alignment is longitudinal but little of the surface at a higher level is preserved. Margin of ?chalaza about 10 mm. from the terminal basal scar. Thickness of fruit wall between the equator and basal scar about 1·25 mm., above the equator only about 0·5 mm. External surface of fruit smooth but much abraded. Cells seen in sections of the fruit wall equiaxial, about 0·018 to 0·025 mm. in diameter, not showing any marked columnar arrangement the texture being compact and close. In patches the cells are seen to be very thick-walled and the lumen is small.

Remarks. One fruit, now collapsed, from coarse sand near the base of the cliff at Southbourne, east of the stairway to the beach which existed in 1938. There is a marked resemblance to *Carpolithus arnensis* from the Dorset Pipe-clay Series of Arne. Probably the condition of the abraded specimen explains why in the Southbourne material the surface fibres are less conspicuous, also owing to the broken condition their branching above the equator is not shown. Further no clearly differentiated inner wall of columnar cells has been seen. Nevertheless the resemblance to *C. arnensis* is so marked that the Southbourne fruit has been referred to this species.

Carpolithus mudense n. sp.

Plate 22, figs. 38–41

Diagnosis. Style apical in line with the ventral margin, patent, stiff, base more or less pointed. Dorsilateral and ventral margins with narrow ribs. Length of endocarp about 1·8 mm.; lateral faces unequal about 0·4 to 0·7 mm. in breadth.

Holotype. V.43549.

Description. *Carpel*: Narrowly cuneate in transverse section, oboval or semioval in outline, broadest at or above the middle, dorsal face convex longitudinally, style apical more or less in line with straight or slightly convex ventral margin, patent, stiff, lateral faces flat, unequal in breadth, dorsal face flat transversely but frequently collapsed and concave in the upper part. All three margins are defined by narrow but well marked flanges or ridges, base more or less pointed or narrow truncate; thickness of pericarp, 0·025 mm. Surface smooth, in the best preserved specimen formed of irregular cells about 0·012 mm. in diameter which produce longitudinal striations on all the faces; another specimen with surface less well preserved shows obscure striations or crumplings directed from the ventral margin obliquely upwards, and near the apex following the dorsal curvature; yet others show close-set equiaxial cells from 0·025 to 0·03 mm. in diameter. Locule lining longitudinally striate with irregular striae, 0·015 to 0·016 mm. apart and with some indication of polygonal cells also, about 0·015 to 0·016 mm. in diameter. Dimensions of two specimens: 1) Length (including style), 1·8 mm.; breadth of lateral faces, 0·4 to 0·7 mm.; breadth of dorsal face, 0·5 mm. 2) Length (including style), 1·8 mm.; breadth of lateral faces, 0·5 and 0·7 mm.; breadth of dorsal face, 0·5 mm.

Remarks. It has been impossible to identify this well-characterized carpel which has therefore been referred to *Carpolithus* with a specific name to indicate its origin. In addition to the figured material there are V.43552–54. All are from the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 22, figs. 42, 43

DESCRIPTION. *Seed*: Tubercled, in the character of its surface ornamentation bearing a strong resemblance to *Hantsia pulchra* (p. 78) but instead of being curved it is apparently anatropous, suboval in outline with a median longitudinal rounded ridge on one face presumably representing the raphe (Pl. 22, fig. 43). This ridge emerges at the narrow end of the seed, the point of emergence presumably indicating the chalaza within. There is a rough semicircular scar representing the hilum (Pl. 22, fig. 42) from which the tubercles diverge. Owing to distortion and flattening the two organs are subterminal on the broad surfaces instead of strictly terminal at opposite ends of the seed. In transverse section the two surfaces of the seed can be distinguished pressed closely together. Each wall is about 0·05 mm. thick and is formed of a thin, black, shining outer skin and a thicker, light brown, close-textured inner coat. The surface tubercles formed by the black outer coat are very variable in size and shape, some being 0·025 by 0·125 mm. across, others 0·05 by 0·05 mm. and so on. The tubercles are digitate and interlocking around their bases as in *Hantsia* but no trace of a raphe ridge is seen in that genus in which the seed is clearly campylotropous. Length of seed, 3 mm.; breadth, 2·5 mm. From the Lignite above the Boscombe Sands, Southbourne. Relationship not known.

Carpolithus sp.

Plate 22, figs. 44, 45

DESCRIPTION. *Pod* (or endocarp): Elongate ovate flattened, more sharply pointed at one end than at the other, ornamented with a coarse network of raised ribs, at first recalling the family Icacinaceae. But there is no evidence of the characteristic pair of knobs or projections which overlie the chalaza and are closely adjacent to the style in the endocarps of Icacinaceae, nor is there any clear evidence of a lateral funicular canal. The carpel is about 0·15 mm. thick, it is formed of angular cells, sometimes oblong, the diameters varying from about 0·016 mm. to 0·05 mm.; their outlines are slightly sinuous and their arrangement appear to be irregular. The testa which adheres to the endocarp shows corresponding cells on its outer surface, but has an inner layer of fine equiaxial angular cells about 0·008 mm. in diameter. Two specimens from Sandbanks, one much sand-pitted, the other broken. Length of the best preserved specimen, 7·75 mm.; breadth, 3·6 mm.

Carpolithus sp.

Plate 22, figs. 46, 47

DESCRIPTION. *Seed*: Subovoid, convex on one face, flattened on the other which bears an obscure longitudinal irregular ridge low and rounded at the broader end, at the extremity of which there may be an organ, sharper and more conspicuous at the narrower end where there is evidence of another organ. On each side of the ridge is an obscure longitudinal depression. The opposite convex face has a still more obscure longitudinal ridge with indications of other ridges arising from the broad end. Whole surface deeply and conspicuously dimpled, with about eight or nine dimples in the length. Testa formed superficially of small polygonal cells

about 0·016 mm. in diameter. Length of seed, 1·5 mm.; transverse diameter, 0·7 mm. in the plane of the ridges; 0·75 mm. at right angles to this plane.

Remarks. One seed, from Sandbanks.

Carpolithus sp.

Plate 23, fig. 1

Description. *Fruit*: Almost half inferior. Calyx persistent, equal to the fruit in length, five-partite, much thickened at the base where it measures 0·4 mm., accrescent for about one-third of its length, sepals free above, thickness at the limit of accrescence about 0·2 mm. Sepals imbricate. Surface of calyx rough, with irregular striae 0·025 mm. apart, smooth where the sepals overlap, texture leathery. Lining layer of sepals light brown, thin, formed of small obscure cells.

Carpel: Syncarpous, arranged around a woody axis which extends from base to apex, ovoid, obscurely five-lobed at the apex, indehiscent. Surface formed of subrectangular cells, about 0·025 mm. in diameter, arranged in longitudinal rows. Walls hard, formed of two fused coats, the outer coat of parenchyma, close-textured, black, 0·05 mm. thick at the apex, 0·1 mm. thick about the middle; the inner coat loose-textured, light brown, about equal to the outer in thickness, shining and finely striate transversely on the internal surface, the striae 0·016 mm. apart. Endocarp formed of loose-textured, glistening, coarse cells, its external surface shining and transversely striate. The locules also appear to be shining and transversely striate. The curvature of the cells at the apex suggests that the seeds were pendulous but none have been seen; locules also very obscure. Length of fruit complete, 3·8 mm.; maximum breadth of fruit inside calyx, 1·6 mm.

Remarks and Affinities. The form and structure of this unique specimen from Sandbanks suggest relationship with Epacridaceae, but as in this family the calyx is usually accrescent for a shorter distance no determination is made.

Carpolithus sp.

Plate 23, figs. 2, 3

Description. Two subglobular specimens ornamented with a network of sharp ridges producing conspicuous pits coarser on one than on the other. No organs have been seen nor any trace of cells nor of triradiate markings. One specimen is broken and shows a compact, thin, perhaps chitinous, wall. The other has now disintegrated. The nature of these objects from the Highcliff Sands, Cliff End, Mudeford, is obscure. Their diameter is about 0·85 mm. A similar specimen from Horizon A3 of the Lower Bartonian of Highcliff is figured by Chandler (1960, pl. 35, fig. 163).

Carpolithus sp.

Plate 23, figs. 4, 5

Description. *Seed*: Small, subglobular, 1 mm. in diameter, compressed dorsiventrally. Surface with a raised network of ridges, the ridges narrow but rounded and shining. One side of the specimen is convex, on the other side there is a single small depression. The meshes have

very slightly sinuous walls and are about 0·05 to 0·1 mm. in diameter; sometimes a short branch arises from one of the ridges and dies out abruptly in the middle of the hollow of a mesh without uniting with the opposite ridge. The relationship has not been determined. From the Lignite above the Boscombe Sands, Southbourne.

Carpolithus sp.

Plate 23, figs. 6–9

DESCRIPTION. Half of a lanceolate (?) woody valve of a one-loculed, bisymmetric, two-valved fruit which had split longitudinally in the plane of symmetry and was broken irregularly at the narrower end (never actually seen). The fruit appears to have been truncate at one end and perhaps shows traces of a perianth base here but there is no sign of a plug. The walls are formed of equiaxial radially arranged cells, about 0·025 mm. in diameter. The external surface is ornamented with obscure, slight, broad longitudinal ribs, also with obscure pits sometimes equiaxial, more often elongate and longitudinally aligned, 0·05 to 0·075 mm. in length, and with obscure longitudinal striations about 0·02 mm. apart. Thickness of wall, 0·15 to 0·2 mm. Surface of locule with longitudinal striations 0·025 mm. apart. Length of fruit (incomplete), 2·75 mm.; breadth, 1·6 mm. Breadth across broken end, 1 mm.; breadth across truncate end, 0·75 mm.

A second specimen is somewhat smaller, narrower and less worn so that the cell structure is better preserved, the surface ridges are more even, the surface cells are clearly longitudinally elongate and aligned. Maximum breadth of these cells 0·05 mm. becoming narrower towards the truncate end, the longitudinal striations are about 0·026 mm. apart. The thickness of the wall is 0·2 mm. The cells of the interior are seen to be finely toothed and longitudinally elongate so as to form longitudinal striations 0·026 mm. apart. Length of fruit (incomplete), 2·8 mm.; breadth, 1·25 mm. at the broadest part, 0·5 mm. at the truncate base end. Both from the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 23, figs. 11, 12; Text-fig. 27

DESCRIPTION. *Seed*: Anatropous with dorsal raphe, oval in outline, broadly truncate at the base, dorsiventrally compressed, triangular in cross-section, one angle being median on

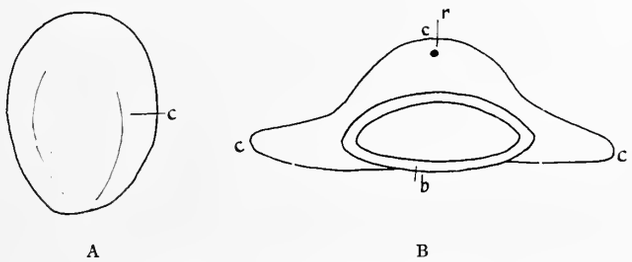


Fig. 27. *Carpolithus* sp. A, Seed showing broad surface and marginal corky rim, *c*. B, Seed, transverse section, showing dorsal raphe, *r*; corky ribs lying dorsally and laterally, *c*; bony coat of testa, *b*.

the dorsal face, the other two lateral, the angles being continued to form a triangular base within which is a subtriangular deeply depressed hilar scar. Testa formed of an uneven but shining epidermis, with cells 0·016 mm. in diameter, within which are three longitudinal corky ribs (cells 0·016 mm. in diameter) forming the angles and extending from base to apex (Text-fig. 27). The dorsal rib as seen in transverse section is 0·5 mm. broad and 0·17 mm. in radial diameter, the lateral ribs are 0·3 mm. in breadth and radial diameter; inside the corky ribs are unevenly distributed ovoid air spaces, next follows a continuous bony coat 0·125 mm. thick. This coat is in contact with the thin epidermis on the ventral side of the seed where no corky thickening occurs. It is formed of compact parenchyma (cells 0·016 mm. in diameter) and it encloses a seed-cavity with a glistening surface formed by oblong longitudinally aligned cells with faceted ends, 0·033 mm. long by 0·02 mm. broad. The seed-cavity is oval in transverse section. Tegmen partially fused with the testa, shining, translucent, formed of equiaxial cells, 0·008 mm. in diameter, arranged in accurate longitudinal rows giving rise to fine longitudinal striae. The striae diverge from the circular chalaza (0·15 mm. in diameter) which lies apically on the ventral surface. A concentric arrangement of cells is also noticeable for a short distance immediately around the chalaza; the raphe lies within the dorsal corky rib; where seen in a transverse section at about 1 mm. from the base of the seed, it lay at about one-third of the thickness of the rib from the external surface. Length of seed, 2·5 mm.; greatest diameter, 1·5 mm.; diameter at right angles to this, 0·8 mm. Breadth about the middle (as seen in transverse section) without the corky ribs, 1 by 0·4 mm. Dimensions of base, 0·8 mm.; dimensions of hilar depression, 0·35 by 0·45 mm. In a second seed the depression measures 0·3 by 0·5 mm.

Remarks and Affinities. Two seeds not identified; one was fractured transversely, whereupon the upper half of the testa fell to pieces leaving the tegmen adherent to the lower half with the chalaza exposed at its free apex. Later the second specimen was also fractured transversely. Both seeds show the sectioned raphe on the cut surfaces. The arrangement of the organs and general structure of the testa are in close agreement with that seen in Lythraceae seeds. But in no genus has a comparable arrangement of the corky ribs been found nor a large basal aperture. Both are from the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 23, figs. 13, 14

Description. *Fruit*: Small much flattened, approximately bisymmetric, obcordate, showing an elongate scar (of attachment?) at the slightly thickened emarginate base and narrowed to a point at the apex. On one side is a short median ridge near the base which appears to be structural and may indicate a septum or funicle (Pl. 23, fig. 13). Both surfaces have a longitudinal rounded ridge near the margin probably due to distortion. The median ridge and the appearance of two small adjacent circular scars at the pointed end strongly suggest a two-loculed fruit, with a locule on each side of the median ridge. Surface rugose with irregular striae formed by obscure cells longitudinally aligned. The form somewhat suggests *Alnus*, but the specimen differs from any species of that genus so far examined in its emarginate base. In *Alnus* the base is straight and prominent and there is a single-seeded

locule. Length of fruit, 1·75 mm.; breadth, 1·6 mm. From the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 23 fig. 15

DESCRIPTION. *Fruit*: Lanceolate, narrowing to the apex which is very slightly emarginate (owing to two style bases?), base obliquely truncate with attachment on the truncation, median area inflated on both surfaces surrounded by a marginal flange which is very slightly crinkled towards the apex on the shorter margin. One surface of the fruit is uniformly convex, the flange being indicated only by the direction of the cells, on the other surface the flange is wider and differentiated from the body by shallow concavities. Surface cells approximately equiaxial, about 0·016 mm. long over the axis of the fruit, arranged in longitudinal rows, having thickened lateral walls which produce a longitudinally striate effect. Near the attachment the striae are 0·02 mm. apart. Length of fruit, 3 mm.; breadth, 0·85 mm.; thickness about 0·35 mm.; thickness of wall, 0·016 to 0·022 mm. One margin is broken in the lower half of the specimen. Its relationship has not been determined. From the Highcliff Sands, Cliff End, Mudeford.

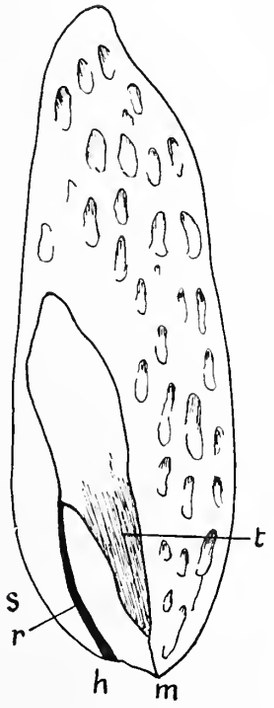


Fig. 28. *Carpolithus* sp. Seed fractured longitudinally at the hilar end to show hilum, *h*; micropyle, *m*; tegmen, *t*; broad suture for splitting, *s*, traversed by raphe, *r*.

Carpolithus sp.

Plate 23, figs. 16, 17; Text-fig. 28

DESCRIPTION. *Seed*: Lanceolate or elongate-oval in outline, bisymmetric, surfaces convex or flat, ornamented with irregular elongate rugosities showing a tendency to longi-

tudinal alignment, obliquely truncate at the hilar end, narrowed to the other (apex). There is a marked tendency to split along a smoothly finished suture in the plane of symmetry down one margin. Surface light brown, spongy, formed of equiaxial cells about 0·016 mm. in diameter. Inner layers of testa surrounding cavity hard, black, shining, about 0·025 mm. thick, external surface of this layer (as deduced from sections) evenly pitted. Lining of cavity dark and shining formed of elongate cells producing longitudinal striations about 0·007 mm. apart. Raphe traversing the suture diagonally from the truncate base to the seed-cavity which it enters at about one-quarter of the length from the base. Tegmen semitranslucent, formed of elongate cells giving a longitudinally striate surface, striae about 0·007 mm. apart. Lining layer transversely striate formed of transversely aligned cells about 0·01 mm. apart. Length of seed, 2·15 to 2·25 mm.; breadth, 0·7 to 0·75 mm.

Remarks. Two specimens from Sandbanks, one of which has been fractured to show the internal structure. No comparable living form has so far been recognized.

Carpolithus sp.

Plate 23, fig. 18

Description. *Endocarp*: Subcircular or somewhat elliptical (but incomplete and distorted). External surface rugose owing to numerous rounded or somewhat elongate tubercles which diverge from a point at one end of the longer axis perhaps indicating the presence of an organ. Equiaxial cells, about 0·033 mm. in diameter, are arranged radially around the bases of the tubercles and in a columnar manner where the wall is seen in section. Internal tissues too decayed for description. Diameter of endocarp, 2 by 2·4 mm. From Sandbanks.

Carpolithus sp.

Plate 23, figs. 19–21

Fragments of incomplete pods show peculiar broad raised branching fibres, but it has not been possible to determine their relationship. From Sandbanks. V.43563 is unfigured.

Carpolithus sp.

Plate 23, fig. 22

Description. *Fruit*: Several-carpelled, possibly with a gynobasic style. Two carpels (schizocarps) seen have started to split from the style and from one another; they were attached basilaterally to a coarse-celled receptacle. The specimen is represented by an external cast with adherent much decayed remains of the carpel showing equiaxial shining cells. The poor condition makes it difficult to interpret, but the above seems the most probable explanation. It is impossible to tell how many carpels were originally present. Length of style about 9 mm.; length of a carpel about 7 mm.; length of a carpel above the receptacle about 5 mm. The relationship has not been determined. From the Freshwater Beds between Alum and Durley Chines, Bournemouth. V.43576 is a doubtful unfigured specimen.

Carpolithus sp.

Plate 23, figs. 25–35

DESCRIPTION. Small seeds, sporangia or sporocarps subcircular or oval in outline (now flattened), with an organ at one end (attachment?) and a longitudinal ridge (raphe?) arising at this organ and terminating in a prominence at the opposite end. Surface formed of equiaxial cells about 0·025 mm. in diameter. Affinities not determined. Dimensions, 1·05 by 0·65 mm.; 1 by 0·85 mm.; 0·75 by 0·8 mm. In addition to figured material there is V.43606 from Sandbanks and ?V.43608 from Branksome Dene.

Carpolithus sp.

Plate 23, fig. 36

DESCRIPTION. An oval laterally compressed fruit or sporocarp with an organ indicated by a small projecting mucro at the middle of one side. Surface smooth but finely pitted, the cells or pits measuring 0·0125 mm. in diameter. In section, the wall is finely columnar. Length of specimen, 0·9 mm.; breadth, 0·7 mm. The relationship and nature have not been determined. It may be a sporocarp or spore rather than a seed or fruit as suggested by the texture of the wall. From the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 23, figs. 37, 38

DESCRIPTION. *Fruit*: Pointed elliptical much compressed, 3·5 mm. long and 3 mm. broad, with two broad surfaces separated by two narrow marginal concavities, possibly flanked by four wings. There is a ridge or rib down the middle of one of the broad faces and on the other a somewhat inflated area (like a seed-body lying in the middle of a wing, Pl. 23, fig. 37) from which occasional ridges diverge. The surface is transversely striate. From a Leafy lenticle in Marine Beds, cliff base, Southbourne.

Carpolithus sp.

Plate 23, figs. 43, 44

A detached valve of a fruit (or half of a coccus) which has split septicidally and loculicidally. The septicidal surface is flat and coarse-celled, the loculicidal surface is shallow concave so that the radially aligned locule was almost flat. The carpel wall is of angular cells about 0·03 to 0·05 mm. in diameter like those in *Wetherellia variabilis*. The locule surface where preserved is finely striate in parts, in other places remains of large equiaxial angular cells are seen with raised walls about 0·025 mm. in diameter. The external wall of the carpel is too abraded to show its original structure. Along the ventral wall of the locule above the middle are remains of the seed, longitudinally striate with striae 0·016 mm. apart. At the end of the locule furthest from this point is a narrow flattened canal leading to the exterior. Length of fruit, 12·5 mm.; dorsiventral thickness, 3 mm.

REMARKS. One specimen, now much broken, from Honeycomb Chine, Boscombe. In general arrangement, septicidal and loculicidal splitting and the coarse angular cells of the

thick carpel wall the specimen recalls *Wetherellia*. Only a fragment of seed has been seen, however, and there is no evidence of the characteristic arched funicle springing from the axial fibre strand and traversing the flat surface of the locule to the pointed hilar end of the seed. Again the flattened canal passing to the exterior from the broad end of the seed is not seen in *Wetherellia*. The specimen must therefore be relegated to *Carpolithus* until further material is available.

Carpolithus sp.

Plate 24, fig. 1

[*Note*: The specimen is described as a seed; it is too poorly preserved to give conclusive evidence as to its true nature; it may have been a winged fruit.]

Description. *Seed*: Probably anatropous, elongate-oval in outline, compressed, having an ovate seed body from one margin of which arises an oblique lateral wing, thin, but probably stiff in texture. A strand of fibres (raphe?) can be traced from the broader end of the seed body (chalaza?) along the junction of body and wing to the narrower end and thence along the margin of the wing to which it forms a stiff edge. Distal end of the wing incomplete, so that the position of the hilum cannot be precisely determined. The raphe branches near the chalaza giving off a thinner fibre which dies out gradually along the opposite margin of the wing. Length of seed (incomplete as preserved), 18mm.; breadth, 7 mm.; length of seed body, 5·5 mm.; breadth of seed body, 3·75 mm.

Remarks and Affinities. The arrangement of body, wing and fibres precludes ascription to the Gymnospermae; it recalls *Toona* M. Roemer (Meliaceae) but the seed body is much broader and the whole seed is larger. Relationship with Proteaceous seeds is excluded by the fibrous character of the wings in this family and by the fact that the seeds have no comparable fibre strand. *Carrierea* Franch. (Bixaceae) is distinguished by the course of the fibre which delimits the margin of the wing; this arises from the base of the seed body and passes directly along the wing margin, without following the junction of wing and seed body.

Winged seeds are common among angiosperms, hence without some knowledge of the fruit, or fuller knowledge of the fossil and of living seeds, a satisfactory determination cannot at present be made. From the Freshwater Beds, Canford Chine, Bournemouth.

Carpolithus sp.

Plate 24, fig. 4

Description. *Fruit*: Ovoid with persistent inferior perianth, five-partite above for about five-sixths of its length, united below, borne on a persistent short stalk. The perianth segments adhere closely together except at the extreme tip where there is a small aperture between them. Surface very finely pitted and somewhat coarsely puckered. Internal structure unknown. Length of fruit, 1·75 mm.; breadth, 1·25 mm. From Sandbanks.

Carpolithus sp.

Plate 24, figs. 5, 6; Text-fig. 29

Description. *Pod* or *Fruit*: Elongate, angled?, five-loculed, finely pitted superficially, splitting loculicidally into five valves, septa and walls woody, about 0·4 mm. thick, axis rela-

tively thin, placentation axile?, a thin radial wall, seen in section, may represent a placenta projecting from the axis into a locule. The valves of the pod curl on splitting. Length of pod (imperfect), 45 mm.; breadth, 17·5 mm. A second more incomplete specimen was found between Alum and Durley Chines, Bournemouth (Pl. 24, fig. 6), and a poorly preserved but similar carbonaceous pod occurred in the Upper Hengistbury Beds embedded in a piece of

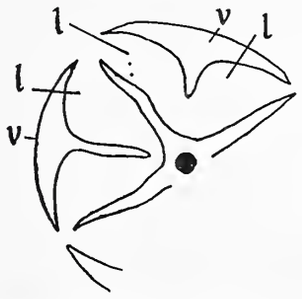


Fig. 29. *Carpolithus* sp. Diagrammatic transverse section of part of loculicidal fruit. *l*, locules; *v*, valves.

ironstone but the latter is not figured. The Bournemouth specimens were represented by sandy internal casts with rapidly decaying carbonaceous remains now almost all disintegrated. The evidence in all cases is insufficient for determination. V.32108 (figured Pl. 24, fig. 5) also included a twig and leaves with cuticle and a cone-scale of *Cupressistrobus gardneri* (holotype).

Carpolithus sp.

Plate 24, figs. 7, 8

Description. *Fruit*: Loculicidal with radially arranged locules and rugose longitudinally but irregularly ridged outer surface represented by two specimens from the Freshwater Beds between Durley and Middle Chines, Bournemouth. They apparently show opposite ends, both being perfect at one end only. The larger specimen is pointed at the complete end (apex?) into which it gradually tapers; it is broken along the ventral angle. The smaller, unfigured specimen (V.43580) is incurved and rounded at the perfect end (base?). One locule of the larger specimen is crushed and flattened, the other is clearly exposed. There is no trace of septicidal splitting into cocci as in *Wetherellia*. The texture has become vitreous so that its structure is obscure but equiaxial cells can be seen in the carpel wall about 0·025 mm. in diameter. The locule lining is finely striate transversely, overlying it are the remains of a light-coloured coat (testa?) formed of digitate cells about 0·05 mm. in diameter. Length of larger valve (somewhat incomplete), 13·75 mm.; breadth, 4·25 mm. Length (incomplete) of smaller valve, 8·5 mm.; dorsiventral thickness, 3·5 mm.; breadth from side to side, 3 mm. The relationship has not been determined.

Carpolithus sp.

Plate 24, fig. 9

Description. *Fruit*: Probably ovoid but very incomplete and much distorted. External surface rugose, the rugosities diverging from a point near one end, suggesting that this was

either the base or apex misplaced by distortion from its terminal position. Surface of locule lining longitudinally striate. The decaying tissues of the interior represent the remains of a septum; so there must have been more than one locule. The data at present available are insufficient for determination of the specimen. Length, 6·5 mm.; diameter as preserved, 4·5 mm. From Sandbanks.

Carpolithus sp. (Family Lythraceae?)

Plate 24, fig. 10; Text-fig. 30

[*Note*: This specimen is described provisionally as a seed, the most probable interpretation of its nature.]

DESCRIPTION. *Seed*: Apparently anatropous, approximately semicircular in outline with ventral margin almost straight; rounded cuneate in transverse section, micropyle and hilum

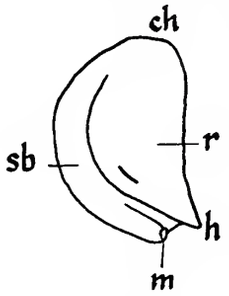


Fig. 30. *Carpolithus* sp. Diagram showing suggested structure of seed. *h*, hilum; *r*, raphe; *m*, micropyle; *sb*, seed body; ch, chalaza.

probably terminal at one end. Testa thin, surface shining with indications of a thin superficial layer finely striate longitudinally, striae 0·007 mm. apart; within is a coat formed of large elongate cells averaging about 0·1 by 0·02 mm. but varying somewhat in size; towards the ventral margin they have a general longitudinal alignment, towards the dorsal there is a general radial alignment, and between they are variously oriented in a disorderly manner (Pl. 24, fig. 10). Over the dorsal surface there are indications that the testa is formed in part of a coat of equiaxial angular polygonal cells 0·012 mm. in diameter, possibly also of a coat (now decayed) of larger cells 0·05 mm. in diameter. The testa has split symmetrically on both sides of the seed along a line parallel to the dorsal margin which separates a narrow thickened semicylindrical dorsal portion (seed body?) from a laminate ventral portion which partially embraces it (raphe?), the two regions being delimited by a sharp ridge. The fissure begins at the hilum, narrows and then dies out at the opposite end of the seed. The symmetry of the fissure on both sides suggests that it may have been connected with germination. The micropyle is seen as a circular scar at the free tip of the 'seed body'.

REMARKS. In this specimen from Cliff End, Mudeford, the character of the surface and possibly the form of the seed recall Lythraceae in which the raphe may partially embrace the seed body (cf. *Pachyspermum quinquiloculare* Reid & Chandler, 1933: 419, pl. 22, figs. 1–21) but no comparable living seed is known.

Carpolithus sp.

Plate 24, fig. 11

DESCRIPTION. *Fruit*: Large with rugose integument, ovate, probably originally ovoid, but now much compressed, with an organ at the pointed end. Surface rugosities arranged in irregular longitudinal rows. Outer coat thick and, as seen in section, formed of small equiaxial cells, but the texture is close and compact and individual cells are difficult to see. Lining layer smooth and shining, ornamented with small transversely-aligned depressions or pits. Cavity filled by a brown solid carbonaceous substance (endosperm?). Length, 14 to 16·5 mm.; breadth, 9 mm.

REMARKS. Two fruits from the Freshwater Beds between Alum and Durley Chines, Bournemouth (V.43578 unfigured).

Carpolithus sp.

Plate 24, figs. 12–17; Text-fig. 31

DESCRIPTION. *Endocarp*: Subglobular (somewhat distorted), having two planes of symmetry, one marked by a groove, the other by a thread-like ridge along which there is a tendency

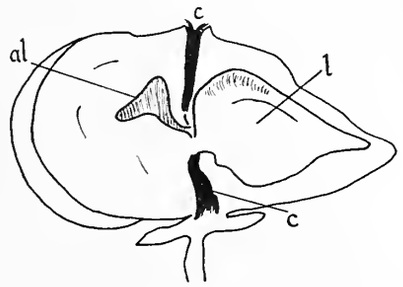


Fig. 31. *Carpolithus* sp. Diagrammatic longitudinal section through endocarp. *c*, canal; *l*, locule; *al*, abortive locule.

to split. Surface nodular. Apex and base each with a large canal both communicating at their inner ends with a large cavity (fertile locule?) on one side and a small cavity (abortive locule?) on the other. Wall thick, compact, formed of equiaxial cells. Lining of cavities obliquely striate, formed of elongate cells. The specimen is difficult to interpret and it is not certain whether the cavities represent true locules. Length of endocarp, 2·5 mm.; breadth, 3·5 by 4·4 mm. Seed obscure, testa apparently formed of small equiaxial cells.

REMARKS. Two endocarps from the Freshwater Beds between Alum and Durley Chines, Bournemouth.

Carpolithus sp.

Plate 24, figs. 18, 19

DESCRIPTION. *Fruit*: Obovoid, either pointed or somewhat truncate above (?according to mode of preservation), with basal receptacle, probably a five-loculed loculicidal capsule

with thin septa. Surface rough, wall 0·3 to 0·4 mm. thick in section, formed of equiaxial, closely compacted cells containing a shining translucent substance. Surface of receptacle very puckered and irregular. Length of truncate specimen including receptacle, 7·7 mm.; breadth (gaping partially), 6 mm. Length of a second specimen with pointed apex, 10 mm.; breadth, 6 mm.

If more and better material with seeds preserved were available, the relationship could probably be traced, but at present no determination has been made. In addition to figured material there is V.43574. All from the Freshwater Beds, between Alum and Durley Chines, Bournemouth.

Carpolithus sp.

Plate 24, figs. 20, 21

DESCRIPTION. *Fruit*: Ovoid but now much compressed, probably originally with four longitudinal flanges or ridges but now so crushed that its original form cannot be determined. Several folds of closely adherent vitreous-looking wall are seen. Length of specimen, 8 mm.; breadth, 5·5 mm. Relationship not known. From Branksome Dene.

Carpolithus sp.

Plate 24, figs. 22–24

DESCRIPTION. *Fruit*: Two-lobed, two-loculed with smooth surface in one specimen and somewhat puckered surface in the other. There are occasional small transverse constrictions. Bluntly rounded at one end, truncate and gaping at the other which is almost certainly incomplete. Septum between the locules indicated externally by longitudinal furrows which may be somewhat oblique. The furrows separate the two lobes of the fruit one of which tends to be larger than the other. The puckered specimen has two subsidiary longitudinal lobes flanking the median groove on one surface but they do not correspond with additional compartments or locules inside. The opposite side of this specimen is flat and its median furrow is conspicuously oblique. Surface highly characteristic, smooth, finely and evenly pitted with equiaxial pits about 0·012 mm. in diameter. Length of fruit preserved, 4·5 to 6·5 mm.; breadth, 3 to 4·5 mm.

REMARKS. Two fruits from Branksome Dene apparently identical with *Carpolithus* sp. (Chandler, 1957: 120, pl. 17, figs. 198, 199) from Bovey Tracey and Heathfield, Devon. The relationship is not known.

Carpolithus sp.

Plate 24, figs. 25, 26

DESCRIPTION. *Seed*: Probably anatropous with longitudinal raphe on the more convex surface. Subtriangular elongate in outline, concave at one end owing to a deep oval depression, sharply pointed at the other. The broad surfaces differ on the two sides of the seed, one side being convex (partially collapsed in one specimen) the other more or less flat. Testa formed superficially of elongate cells with raised walls and bevelled or pointed ends varying considerably in length, about 0·012 mm. broad, beneath which are equiaxial rounded cells, exposed in

one patch, 0·016 mm. in diameter. The form of the seeds and probable position of the raphe suggests that the organs are at the two extremities. Length of seeds, 2·5 mm.; breadth, 1·5 and 1·25 mm. respectively; thickness, 0·75 and 0·5 mm. respectively.

Remarks. Two seeds of which the relationship has not been discovered. From the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 24, figs. 27, 28

Description. *Fruit* (or *Seed*?): Ovoid, now flattened in fossilization with aperture at the pointed end. Surface glistening and crumpled, longitudinal crumples extending downwards from the apex for about half the length and giving place below this level to irregular, rounded, equiaxial crumples. Cell structure obscure. A longitudinal fold or pucker extends from the apex for about half the length on both the broad surfaces, possibly due to crushing. Length, 1·25 mm.; breadth as crushed, 1·1 mm. The specimen, from the Highcliff Sands, Cliff End, Mudeford, has not been determined.

Carpolithus sp.

Plate 25, fig. 1

Description. *Capsule*: Bisymmetric about a dorsiventral plane, oboval in outline, much inflated dorsally (now flattened in fossilization) with a straight longitudinally striate ventral edge, 0·8 mm. long (as measured from the base) which arises from a short stalk, 0·05 mm. long. At its upper end this straight edge is continued into a prominence (style?) below which the fruit gapes loculicidally in the plane of symmetry on the ventral side, the gape being continued 0·1 mm. to the base and over onto the dorsal surface. Free edges of gape smooth, finished, rounded. Carpel wall rather thin, cell structure obscure, but near the apex there is some indication of equiaxial cells about 0·01 mm. in diameter arranged in longitudinal rows. The surface shows many mounds and depressions on both faces of the fruit, irregular in size, shape and distribution, some measuring 0·1 mm. Length of fruit, 1·25 mm.; breadth, 0·7 mm. From the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 25, fig. 2

Description. *Seed*: Suboval in outline, somewhat laterally compressed, with a marked longitudinal angle down one side which suggests a raphe. The surfaces on the two sides of this angle are unequally developed, one being more markedly convex than the other. The specimen is obliquely truncated at one end by a large oval aperture. Surface shining, wall woody, formed superficially and in section of equiaxial cells about 0·016 mm. in diameter. Length of specimen, 1·5 mm.; breadth, 1·1 mm.

Remarks. One specimen (fruit or seed?) the most distinctive character of which is the wide foramen. Few genera show such a character, among them are the seeds of Nymphaeaceae (testa structure quite different) and the fruits of Halorraghaceae, Hippuridaceae, Sparganiaceae

and Cyperaceae. In the last three named families the single-carpelled fruits are circular in transverse section, in the Halorraghaceae on the contrary, the fruits are either syncarpous and multilocular or they break into angular cocci. Nuts of some species of *Myriophyllum* resemble those of the fossil both in size, shape, foramen and cell structure, but the evidence is not sufficiently distinctive to place the fossil in that genus and determination must await the discovery of further fossil material. The appearance is that of a seed rather than of a fruit. From the Highcliff Sands, Cliff End, Mudeford.

Carpolithus sp.

Plate 25, fig. 3

DESCRIPTION. *Seed*: Subcircular, convex on one surface, slightly concave on the other. The convex surface is rugose and deeply puckered, the concave surface is less rugose, but the rugosities are coarser. No organs could be seen. Diameter of seed, 2 mm. From Branksome Dene.

Carpolithus sp.

Plate 25, figs. 4, 5

A beautiful five-sided, five-angled fruit, bud or other organ of unknown affinity from Branksome Dene. Length, 1·3 mm.; transverse diameter, 0·75 by 0·8 mm. Also a similar specimen from Sandbanks. There are other specimens (unfigured) from the Marine Beds, east of the East Cliff lift, Bournemouth (V.43633–34).

Carpolithus sp.

Plate 25, figs. 7, 8

DESCRIPTION. Two pointed subovoid bodies with thick walls and relatively small cavities have not yet been matched among living plants. They do not appear to be ripe fruits or seeds. They are pointed at each end with a small cap-like structure at the more slender end like a stylar scar or the remains of a perianth disc. Hence the organisms may be abortive or very immature fruits. The margins are rounded and the specimens compressed so as to present two broad faces each with a longitudinal median angle although each is actually four-angled. There is a shallow longitudinal furrow between the angles especially at the end furthest from the 'stylar scar'. In the hollows are a number of subcircular, inflated, semitranslucent, shining yellow sacs which sometimes contain a yellow substance (resin?). Along the angles of the specimens the cells are longitudinally aligned. Between the angles when the wall is worn it appears to be formed of loose-textured tissue with cells diverging obliquely from the angles. Length of organs about 2·3 mm. Possibly immature fruits of Mastixioideae? Both are from the Freshwater Beds, between Alum and Middle Chines, Bournemouth.

Carpolithus sp.

Plate 25, figs. 9, 10

DESCRIPTION. *Endocarp*: Truncate oboval in outline, now much compressed, originally more inflated, narrowing rather abruptly to a point at one end, having a gaping aperture at the other. One margin is slightly more convex than the other; a few irregular not very marked

longitudinal ridges lie parallel with and adjacent to this margin. A partition or incomplete septum appears to project into the locule throughout its length, not an infold as in *Mastixia*. Surface of endocarp smooth in texture but not shining, formed of small equiaxial cells, about 0·012 mm. in diameter. In section the wall is formed of curved columnar cells, convex towards the locule, concave towards the truncate gaping end of the endocarp. The wall may be about 0·15 mm. thick or more in places. The locule surface is striate obliquely. Length of endocarp, 7 mm.; breadth, 4·5 mm. From the Lignite above the Boscombe Sands, Southbourne.

Carpolithus sp. (? Juglandaceae)

Plate 25, fig. 28

DESCRIPTION. *Fruit*: Having a large circular wing or possibly two lateral wings surrounding a subconical body distorted and puckered in fossilization so that the original form is obscure. Body represented by an internal cast. Wing or wings a convex impression overlain by remains of carbonaceous substance which seems to have been thick. There are impressions of stout radial fibrovascular bundles and radial striations except that at the extreme edge there is evidence of a smooth marginal band. At the apex of the seed body a short strand of fibres traverses the wing to the margin (? marking a style). Length of fruit including wing, 23 mm.; breadth (somewhat distorted), 18 mm. Length of body about 11 mm. (difficult to measure owing to distortion); breadth, 6 mm.

REMARKS. One specimen from the '*Aniba* locality', i.e. probably between Alum and Middle Chines, Bournemouth. The winged fruit is suggestive of Juglandaceae but evidence from this single, poorly-preserved specimen is insufficient for determination.

Bract?

Plate 23, fig. 10

A thick bract or cone-scale of small dimensions is trifid at the distal end with two long lateral lobes slightly recurved and pointed and a short median lobe with rounded obtuse tip. One surface (upper) is more or less flat but has two conspicuous channels separated by a median ridge (distorted to one side). The other surface is convex. Both are longitudinally striate. On the less curved surface are remains of a shining coat formed of digitate cells (now decayed). Length of scale, 1·5 mm.; breadth, 2 mm.

REMARKS. One cone-scale only from Honeycomb Chine, Boscombe. The specimen bears some resemblance to *Betula* but is smaller and the median lobe is shorter. It has not been possible to determine its systematic position.

Cupule

Plate 24, figs. 2, 3

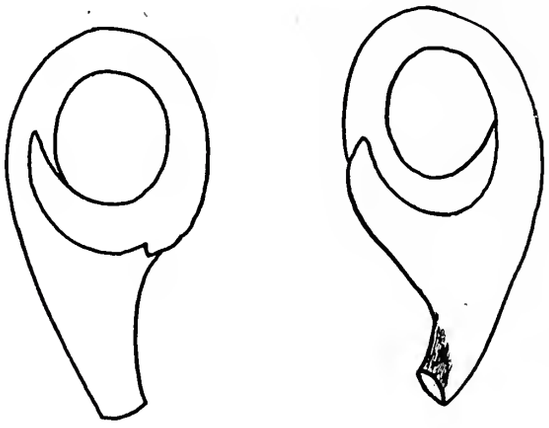
DESCRIPTION. Cupule represented by one half only, more or less subcircular in outline, broken longitudinally thereby exposing the inner surface. At the apex there appear to be remains of three perianth segments, one perfect, two represented by fragments. At the base there is a sharp edge as if the cupule had overlapped the stalk. Internally

there is a ridge at the junction of the cupule and the free perianth segments. External surface puckered and leathery in appearance, probably finely pitted but the pits are rather obscure. Internal surface longitudinally striate? but structure largely destroyed by sand-pitting. Length of cupule, 7·5 mm.; breadth, 8 mm. From the Freshwater Beds, between Alum and Durley Chines, Bournemouth.

Tendril

Plate 25, figs. 11, 12; Text-fig. 32

A tendril with a peculiar hook a short distance below the tip has not been determined owing to lack of knowledge of these organs in living plants. From Sandbanks.



A B

Fig. 32. Opposite sides of hooked tendril.

Spiny petioles?

Plate 25, figs. 13–21

Description. Flattened fragments broken along one margin and bearing one, two or three spines along the opposite margin. Texture woody, the spines being thick and curved. Their nature has not yet been discovered, nor is it certain that all belong to the same type of plant. The appearance suggests spiny margins of petiole fragments. Longest fragment about 7·5 mm. They were found in the Leafy lenticle in Marine Beds, cliff base, Southbourne, in the Lignite above the Boscombe Sands, Southbourne, and in the Highcliff Sands, Cliff End, Mudeford.

Tuber?

Plate 25, figs. 32–34

A number of hollow subglobular bodies, usually burst at one end. The external surface is rough and scaly in parts or black and shining. Many specimens show a superficial skin which tends to flake away like the outer corky skin of a ripe potato. Inside is a skin somewhat

chitinous in appearance which may be very thin or as much as 0·75 mm. thick. No cell structure can be seen except a fine columnar structure in sections of the thick specimens. A thin, inner, semitranslucent skin readily separates from this coat (Pl. 25, fig. 33). Occasionally small, circular-rimmed apertures are seen on the surface. The nature of these organisms is obscure, they may represent tubers, or even insect egg cases. They recall somewhat similar organisms from the Pipe-clay Series at Lake (Chandler, 1962: 157, pl. 27, figs. 24-26) and a solitary specimen from the Lower Headon of Hordle (Chandler 1961*b*: 156, pl. 30, fig. 160). They occur massed together in small pockets in the deposit at Sandbanks and are frequently filled with a fine white substance like pipe-clay. Diameter of bodies commonly 2·5 to 3·5 mm. In addition to figured specimens there are V.43640 from Sandbanks, V.43641 from Branksome Dene, V.43642 from the Marine Beds just east of the East Cliff lift, Bournemouth, and V.43643 from the Lignite above the Boscombe Sands, Southbourne.

Scale?

Plate 23, figs. 23, 24

A curious scale-like object with short round stalk hollowed at the base, apex broken but evidently originally prolonged to form a long apical spine, the prolongation of a median axis. On each side of the axis as seen from the concave (upper?) side is an inflated lateral rounded expansion (Pl. 23, fig. 23). These lobe-like bodies are also seen on the convex (lower?) surface but between them on this side is a more or less lozenge-shaped area like a flattened umbo (Pl. 23, fig. 24) pointed below with divergent striae over the surface on each side of the median line. The original surface (apart from the 'umbo') appears to have been covered by a skin with conspicuous angular or rounded depressions about 0·1 to 0·2 mm. in diameter, separated by thin rounded ridges, the depressions forming a network over the whole surface. The nature of the 'scale', if such it is, has not been discovered. Length of specimen (incomplete), 12 mm.; breadth, 9·5 mm. From the Marine Beds, Honeycomb Chine, Boscombe.

Placenta?

Plate 23, fig. 39

1926 *Carpolithus* sp. 1, Chandler, p. 44, pl. 7, fig. 11*a*, *b*.
1961*b* *Carpolithus* sp., Chandler, p. 155, pl. 30, figs. 154–156.

Identical with specimens described from Hordle. It is not yet clear what plant organ they represent nor what is the systematic position. Largest specimen (V.43610) from the Lignite above the Boscombe Sands, Southbourne, length, 3 mm.; breadth (much flattened), 2·5 mm. There are also two smaller unfigured specimens (V.43611).

Unknown organ

Plate 25, fig. 6

Description. *Organ*: Subovate, narrowed to one end, much flattened, having a single (now flattened) cavity and thick compact woody walls formed of equiaxial cells 0·01 mm. in diameter. Surface with four groups of shining glands? or resinous secretions? lying near the broad end (Pl. 25, fig. 6 shows two of these groups). There are six to ten glands in each group

and individual glands may be as much as 0·1 mm. in diameter. A thin translucent tegmen or skin lies within the cavity. Length of organ, 1·35 mm.; breadth, 0·9 mm.; thickness, 0·35 mm.

The relationship and nature of this specimen from Southbourne is unknown but larger organs (length about 3·75 mm.) with similar glands were found at Studland and in the Bournemouth Freshwater Beds (length, 2·3 mm.) (cf. Pl. 25, figs. 7, 8).

Unknown organism

1962 Unknown organism, Chandler, p. 156, pl. 27, figs. 1–22.

Organisms of sponge-like appearance and unknown relationship occur at various horizons in the Tertiary. They have been discussed, figured and catalogued by Chandler (see above). Specimens from the Bournemouth Marine Beds at Southbourne (cliff base; Leafy lenticle) and Lignite above the Boscombe Sands were there described and figured (p. 157, pl. 27, figs. 7–13).

Unknown organism (Galls?)

Plate 25, figs. 22–27; Text-fig. 33

Description. About a dozen specimens, organisms with the appearance of pods attenuated at one end into a slender stalk or style, always imperfect at the other end. They are considera-

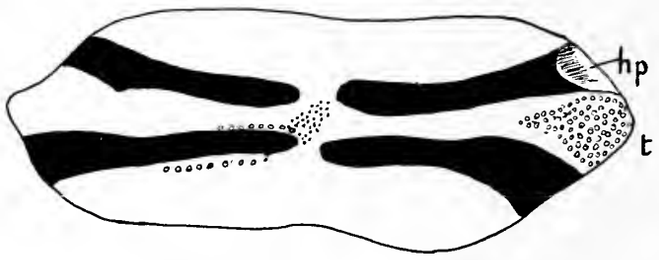


Fig. 33. Gall? Transverse section across pod-like body showing cavities closed by plugs, *hp*, and coarse spongy tissue, *t*.

bly compressed laterally, one margin is almost straight, the other is convex giving the organism a curved appearance. The two flat surfaces show coarse conspicuous nervation; there are three marked longitudinal nerves on each face connected by oblique branches. The margins are thick and flattened, each shows two rows of contiguous circular scars with rough surfaces which are the outer ends of circular plugs. In some cases the plugs have fallen out leaving vertical-sided apertures leading into long, narrow cavities. As seen in transverse sections of the organism these cavities are somewhat compressed at right angles to the flat surfaces. As seen in longitudinal sections parallel with the broad flat surfaces of the organism the cavities lie in two rows arranged in a pinnate manner (Pl. 25, fig. 25). The specimens are formed of spongy tissue with thin-walled equiaxial cells about 0·016 to 0·025 mm. in diameter, in some parts 0·05 mm. in diameter. The cavities are lined by a light brown coat, one cell thick, formed of irregular cells with slightly sinuous walls about 0·012 to 0·016 mm. in diameter. The plugs extend inwards for about 0·3 mm., they are hollow towards the centre of the pod and are covered by similar cells to those which line the cavities.

Remarks. It has not been possible to determine these organisms. The burrow-like arrangement of the cavities suggests some form of gall but no corresponding living type is known, although a somewhat similar appearance occurs in galls on *Rubus*. In addition to the figured specimens there are V.43625 from Sandbanks and V.43626 from below the broken promenade at the cliff base between Alum Chine and Branksome Dene, Bournemouth. The greater irregularity of this latter specimen supports the view that they may be galls.

Galls?

Plate 25, figs. 29–31

Description. Subcylindrical bodies tapering slightly towards the truncate notched apex are formed of woody parenchyma and show a number of superficial circular incisions which mark the margins of cup-like cavities closed by solid plugs of tissue. The 'cups' do not connect with a subcylindrical central cavity of the body (Pl. 25, fig. 31). They are arranged in about seven longitudinal rows, each row containing about five or six 'cups'. Sometimes they are grouped in longitudinal pairs, those of each pair being contiguous (Pl. 25, figs. 29, 30); there may be two pairs below with a single cavity above; a single cavity below and two pairs above; two pairs in the middle and a single cavity below and above; or three pairs of cavities. Each 'cup' is lined by a thin, shining membrane, one-cell thick, formed of elongate cells arranged parallel with the axis of the 'cup', faceted at their extremities. Length of perfect specimen, 6 mm.; breadth, 3 mm.

Remarks. One perfect specimen (V.43627) and a second semicylindrical fragment (V.43628) from the Highcliff Sands, Cliff End, Mudeford. No organs can be seen and the interpretation of these specimens presents great difficulties. They may be galls or peculiar placentae, probably the former.

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New taxonomic names and the page numbers of principal references are printed in **Clarendon** type.
An asterisk * indicates a figure.

PLATES

Explanation of Plate 1

Fig.

Araucarites sternbergi Goeppert p. 39

1. Ventral cuticle showing lines of stomata and, on left, marginal epidermal cells. ×92·6. V.653*a*.
2. Dense fragment of ventral cuticle showing distribution of stomata in two bands one each side of midrib (*m*). Leaf tip missing. Junction of leaf base with twig at (*j*). ×64·8. V.16572 *b*.

Araucarites gurnardi Florin

3. Ventral cuticle of young leaf base, for comparison with Figs. 1, 2. Shows rectangular-ended epidermal cells over midrib and near left margin, also left stomatal band. (*j*) junction with stem. ×92·5. V.43650.

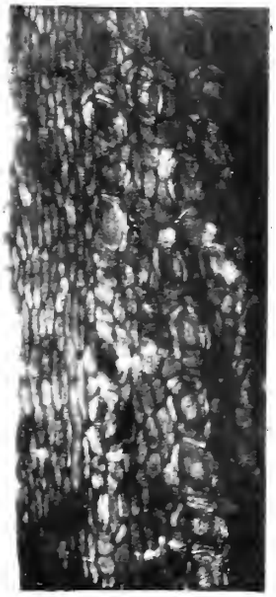
Araucarites sternbergi Goeppert p. 39

4. Fragment of dense dorsal cuticle with few scattered stomata in one stomatal band, from leaf in Fig. 7. ×52·7. V.43647.
5. Fragment of dorsal cuticle showing stomata and, to left, marginal band of ordinary epidermal cells. ×54·5. V.16572 *b*.
6. Ventral cuticle from another twig showing two stomatal bands and three bands of ordinary epidermal cells. It also shows that the left side of the midrib has denser cuticle than the right owing to the orientation of the leaf to the light. ×96·6. V.16572*a*.

Fig.

7. Detached leaf, side view. ×15. Destroyed in preparing cuticle.
8. Part of stomatal band of ventral cuticle of leaf in Fig. 7. ×102. V.43647.
9. Part of same. ×222. (at *x* in Fig. 8.)
10. Detached leaf, side view. Tip broken. ×6·5.
11. Another, complete. ×6·5. Figs. 10, 11 destroyed in preparation of cuticle.
12. Small fragment of ventral cuticle from leaf in Fig. 10. Shows epidermal cells over midrib and extreme edge of right stomatal band. ×101·3. V.43648.
13. Part of same fragment. Three stomata can be seen, and rounded gaps on right-hand edge show where stomata of another longitudinal row have been. Condition of this specimen too fragile to permit of further handling and cleaning of cuticle. Evidence, so far as it goes, suggests *A. sternbergi*. ×200.

Figs. 1, 2, 5, 6 Bournemouth Freshwater Beds, exact locality not specified. Fig. 3 Bembridge Beds, Gurnard Bay, Isle of Wight. Figs. 4, 7–9 Leafy lenticle, cliff base, Southbourne, Bournemouth Marine Beds. Figs. 10–13 Highcliff Sands, Cliff End, Mudeford.



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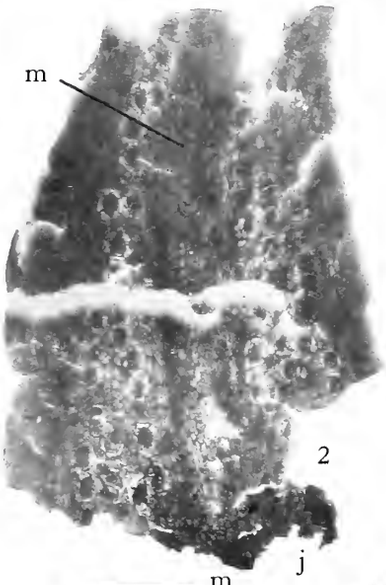

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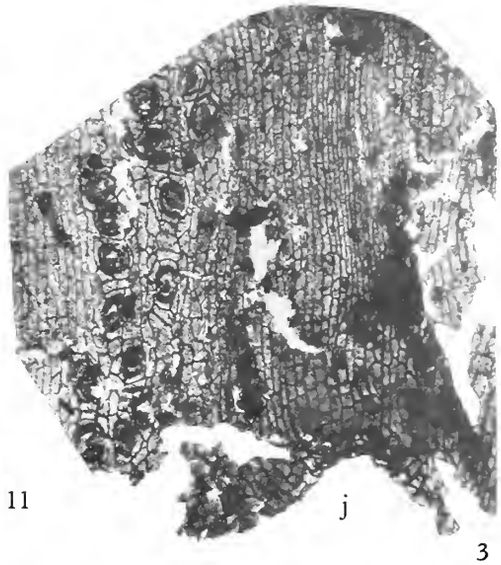

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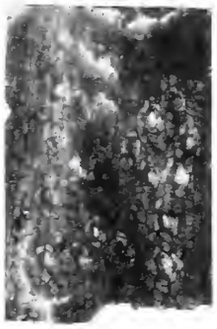

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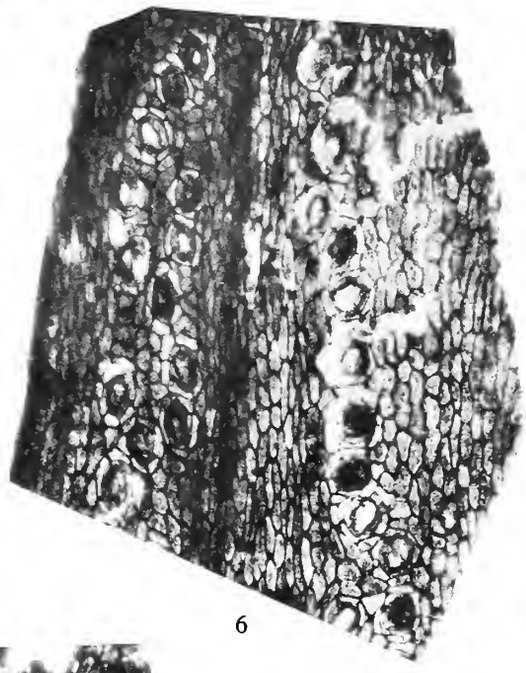

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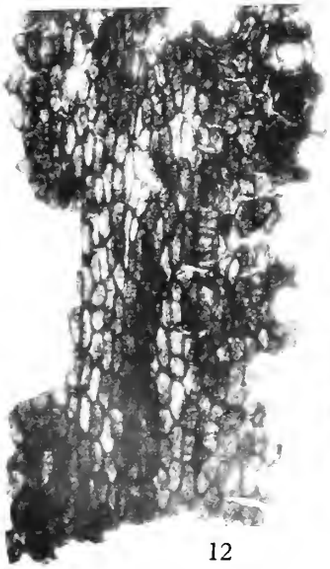

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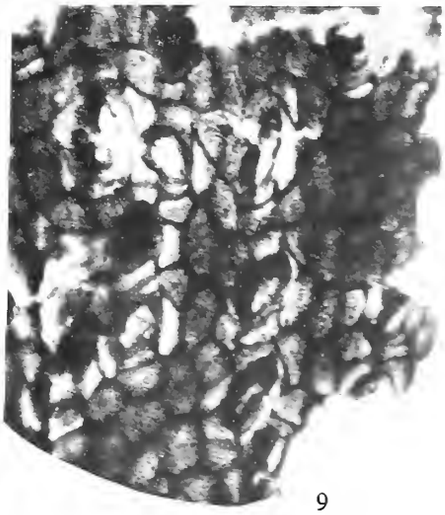

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ARAUCARITES

Explanation of Plate 2

Fig.

Araucarites sternbergi Goeppert p. 39

1. Part of two ventral stomatal bands flanking median band of ordinary epidermal cells (cf. Pl. 1, fig. 6). ×214·8. V.16572*a*.
2. Part of ventral stomatal band (cf. Pl. 1, fig. 1). It shows line of stomata with transversely elongate and aligned epidermal cells between them. ×214·2. V.653*a*.
   Marked reticulation of walls seen in Figs. 1, 2.
3. Part of ventral cuticle of another leaf on same twig showing small papillae on ordinary epidermal cells. ×217·6. V.653*a*.

Araucarites gurnardi Florin

4. Part of ventral cuticle for comparison with *A. sternbergi*. ×209·8. V.43651.
5. Another piece of ventral cuticle from same twig showing typical line of transversely aligned stomata and broad rectangular epidermal cells. ×209. V.43651.

Fig.

Araucarites sternbergi Goeppert p. 93

6. Detached leaf, side. ×15. Destroyed in preparing cuticle.
7. Ventral cuticle from above, showing epidermal cells over midrib and parts of two stomatal bands. Parts of marginal bands of ordinary epidermal cells also seen. ×101. V.43646.
8. Fragment of dorsal cuticle, from above, showing stomatal band. ×100. V.43646.
9. Fragment (dorsal?) showing double row of cells arranged end to end around stomata, and ring of cuticular thickening between guard cells and auxiliaries. ×203·7. V.43646.
10. Part of cuticle on right side near top of Fig. 7. ×222·2. V. 43646.

Figs. 1–3 Bournemouth Freshwater Beds, exact locality unspecified. Figs. 4, 5 Bembridge Beds, Gurnard Bay, Isle of Wight. Figs. 6–10 Honeycomb Chine, Boscombe, Bournemouth Marine Beds.

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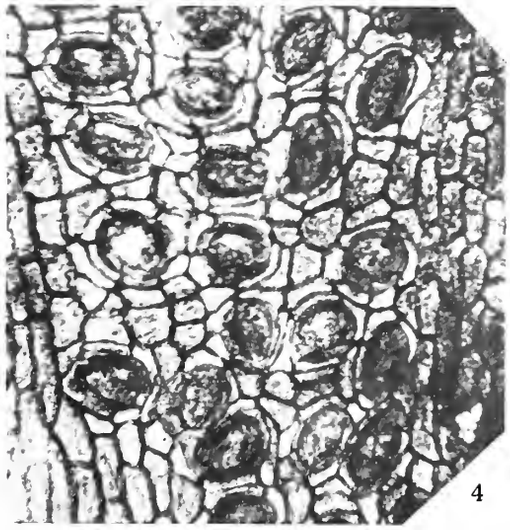

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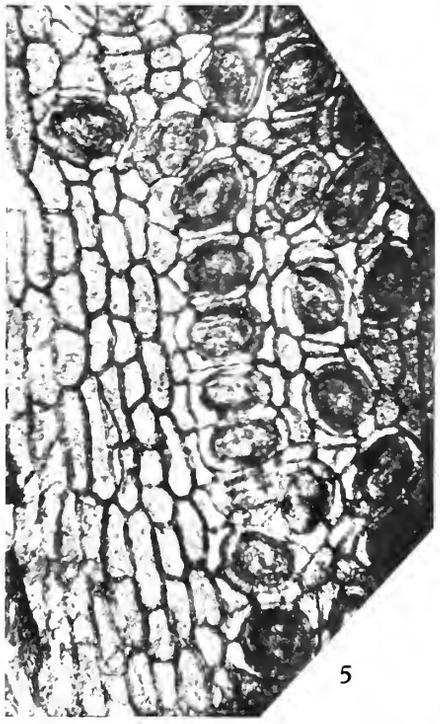

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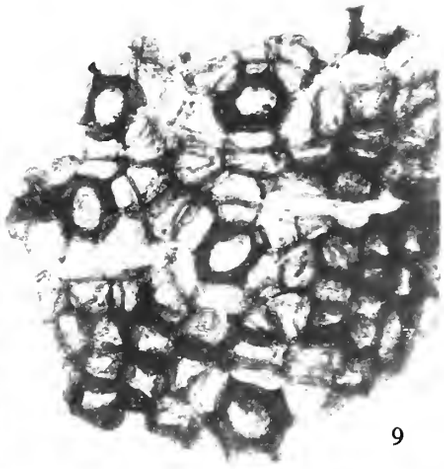

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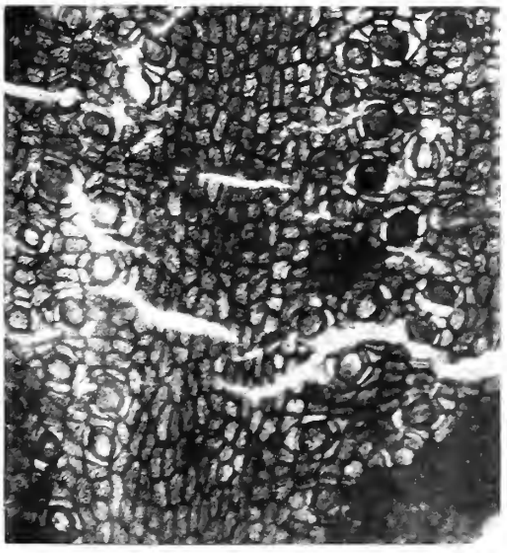

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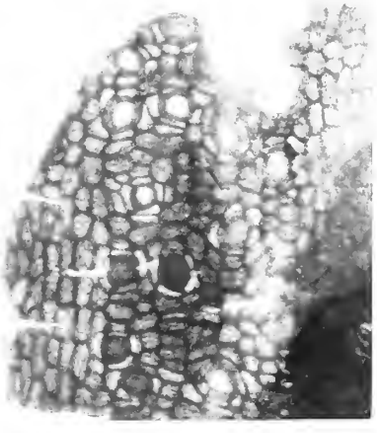

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ARAUCARITES

Explanation of Plate 3

Fig.

Cupressistrobus gardneri Chandler p. 45

1. Holotype. Bifacial twig with broad laterally expanded leaves and small median leaves. Remains of carbonaceous twig and leaves still adhere to impression on sandy matrix. ×2·5. V.32108.
2. Counterpart impression showing median leaf clearly. ×2·5.
3. Same with leaves outlined in ink in explanation of Fig. 2. (*ml*) small median leaf; (*i*) separate imbricate twig of same species with its tip directed downwards; (*s*) part of cone scale showing deep impression made by stalk and about half the circumference. ×2·5.
4. Median leaf in Figs. 2, 3 enlarged. Represented by an impression (*ml*) only but this was originally overlain by a carbonaceous leaf destroyed in preparing cuticle. ×6·5.
5. Impression of small part of a twig named *Podocarpus elegans* and figured by Gardner (1883, pl. 8, fig. 14). It shows a small median leaf (*ml*) for comparison with Figs. 2, 3, 4. Bases of several broad laterally expanded leaves seen on left. ×7. V.14792.
6. Lower part of same twig. Shows small median leaf at (*ml*). Note elongate subelliptical outline which shows that it cannot be merely the decurrent base of one of the large leaves. Second median leaf more obscurely seen at (*ml*2) above. ×7.
7. Middle part of the impression of a branched twig figured by Gardner (1883, pl. 8, fig. 10) as *Podocarpus elegans*. On the right-hand branch a small median leaf impression is seen at (*ml*) sunk in the matrix. ×7. V.14785.
8. Twig impression showing two types of leaf. Three small median leaves (*ml*) can be detected. Specimen shows how obscure the small median leaves are in impressions from which the leaf substance has gone. ×7. V.528.
9. Impression of bifacial twig for comparison. ×2·5. V.46889.
10. Impression of another twig with less marked bifacial habit. ×2·7. V.46458.

Fig.

11. Part of broad laterally expanded leaf from V.32103 with tip and base broken. ×6·5.
12. Another. ×6·5. V.32108.
13. Tip of another. ×6·5. V.32108.
14. Another smaller leaf from same block, tip broken. ×6·5. V.32108.
15. Small median leaf. ×6·5. V.32108.
16. Cone scale (incomplete) from V.32103 showing external surface. Probably hexagonal when complete. ×6·5.
17. Same, side view, showing peltate stalk (*st*); (*f*) facetted margin. ×6·5.
18. Same, internal surface. ×6·5.
19. Detached broad laterally expanded leaf showing longitudinal ridges which simulate fine nerves. ×6·5. Decayed.
20. Another. ×6·5. Decayed.
21. Smaller leaf almost perfect. ×6·5. V.43657.
22. Leaf slightly imperfect at base. ×6·5. Decayed.
23. Another, upper half only. ×6·5. Decayed.
24, 25. Two small leaves, probably median ones from a bifacial twig. ×6·5. V.43656. Fig. 25 decayed.
26. Imbricate twig. ×6·5. Decayed.
27. Another with rather long flat leaves. ×6·5. V.43658.
28. Another of same type. ×6·5. V.43659.
29. Another in which elongation and flattening of leaves is marked. They show a tendency to lateral expansion giving a somewhat bifacial appearance. ×6·5. V.43660
30. Small imbricate somewhat bifacial twig. ×6·5. Decayed.
31, 32. Two battered imbricate twigs, one with immature cone. ×6·5. V.43653–54.

Figs. 1–4, 11–18 between Branksome and Canford Chines; Fig. 8 exact locality unspecified; Figs. 19–30 Branksome Dene; Figs. 31, 32 Sandbanks; all Bournemouth Freshwater Beds. Figs. 5–7, 9, 10 Lower Bagshot, Alum Bay, Isle of Wight.


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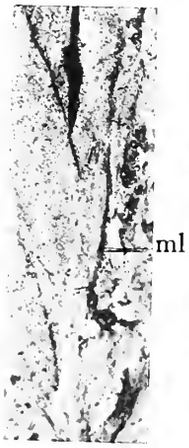

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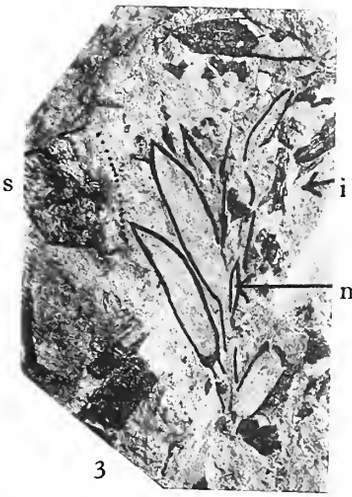

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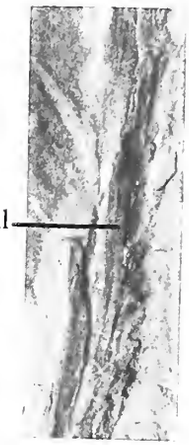

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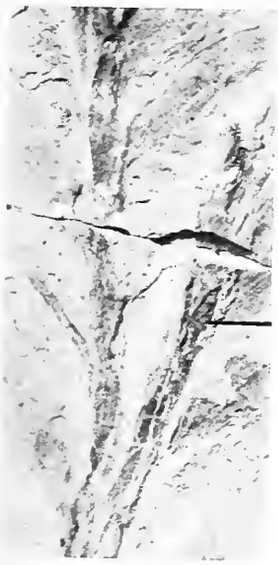

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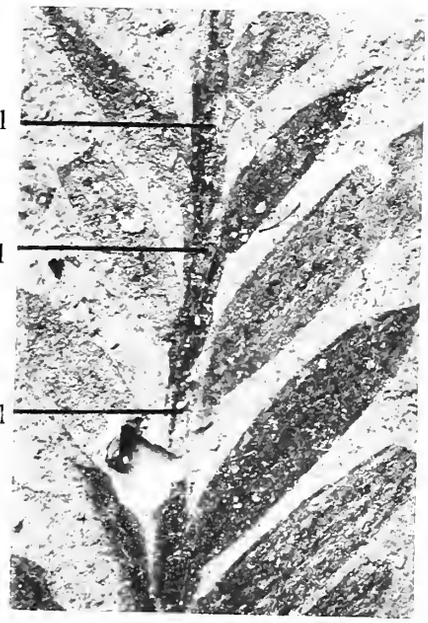

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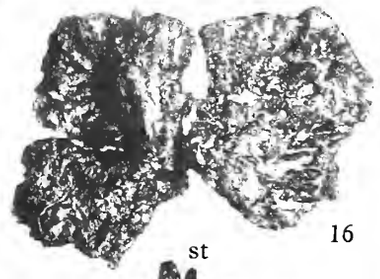
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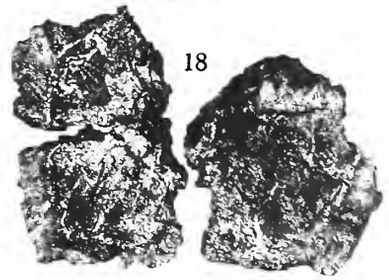
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CUPRESSISTROBUS

Explanation of Plate 4

Fig.

Cupressistrobus gardneri Chandler p. 45

1. Cone scale, exterior, showing characteristic wrinkled surface. ×6·5. V.43663.
2. Same, interior. ×6·5.
3. Small cone scale, exterior, possibly this species. ×6·5. Decayed.
4. Same, interior. ×6·5.

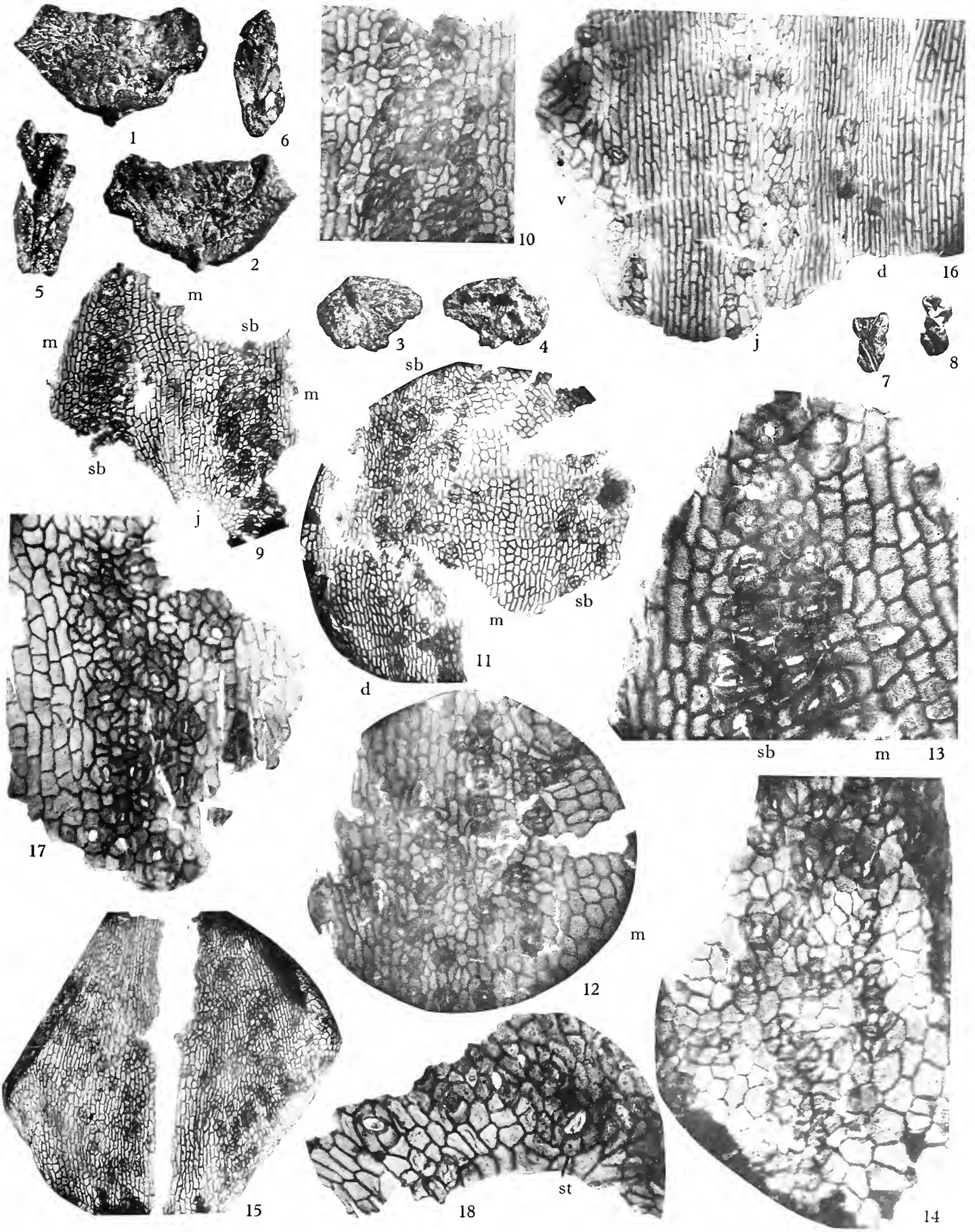
5–8. Four small twig fragments. ×6·5. V.43652. Figs. 6–8 decayed.

9. Part of upper (ventral) cuticle of falcate leaf. (*sb*) stomatal band; (*m*) bands of ordinary epidermal cells over midrib and margins; (*j*) junction with twig. ×61·7. V.43667.
10. Part of right stomatal band in Fig. 9. ×150.
11. Part of lower (dorsal) cuticle of same falcate leaf as in Fig. 9. Decurrent part on left at base of figure at (*d*). Short polygonal cells over median area (*m*) lie between two stomatal bands (*sb*) (both incomplete). ×60·1.
12. Upper part of same, showing cells of median area (*m*) and left stomatal band. ×150.
13. Tip of left stomatal band in Fig. 9; (*m*) median area; (*sb*) left stomatal band. ×225.
14. Part of upper (ventral) cuticle of falcate leaf showing rosette-like stomata with four to six auxiliary cells. ×212 approx. V.43666.

Fig.

15. Dorsal cuticle from decurrent base of falcate leaf from same twig as leaf in Fig. 9. Cuticle has split longitudinally along middle. ×57. V.43666.
16. Part of cuticle from decurrent base of broad laterally expanded leaf of Gardner's *Sequoia tournali*; (*v*) base of ventral surface showing curved line of junction with twig; (*d*) dorsal cuticle; (*j*) junction line of dorsal and ventral cuticles at leaf margin. ×100 approx. V.15103*a*.
17. Part of thin ventral cuticle of leaf from young falcate twig showing stomatal band of stomata with four to six auxiliary cells. ×222. V.43681.
18. Part of thin ventral cuticle near base of a leaf. One stoma (*st*) on right shows seven auxiliary cells. ×222. V.43680. Disorganised in permanent mounting.

Figs. 1–4 Lignite above Boscombe Sands, Southbourne. Figs. 6–8, 17, 18 Bournemouth Marine Beds just east of East Cliff lift, Bournemouth. Figs. 5, 9–15 Sandbanks; Fig. 16 exact locality unknown; all Bournemouth Freshwater Beds.



CUPRESSISTROBUS

Explanation of Plate 5

Fig.

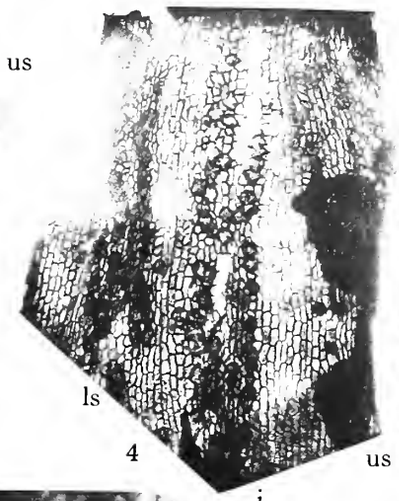
Cupressistrobus gardneri Chandler p. 45

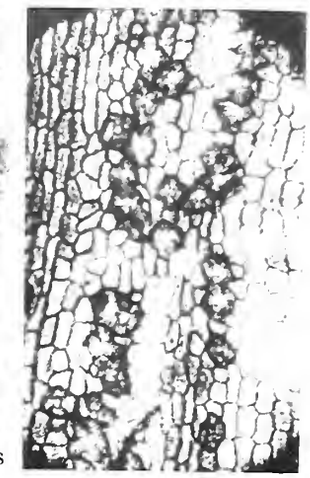
1. Ventral cuticle of tip of flat leaf from imbricate but slightly bifacial twig. Shows thick walled pitted epidermal cells and groups of stomata. Edge of dorsal cuticle still adheres on right at (*a*) near apex. ×55·5. V.43665.
2. Dorsal cuticle near base of same leaf. Decurrent margin at (*d*) (left base). Cells, which are pitted, are narrower and slightly thicker walled than on ventral surface and there are fewer stomata. ×62. V.43665.
3. Cuticle from actual lower surface of an asymmetric laterally expanded leaf near apical end. Morphological upper surface (*us*) occupies right half of figure, morphological lower surface (*ls*) occupies left half. ×57. V.32108*b*.
4. Cuticle from actual upper surface of same leaf. Morphological upper surface occupies right half (*us*), morphological lower surface the left half (*ls*); (*j*) line of junction between these two. ×57. V.32108*b*.
5. Part of stomatal band of morphological lower surface seen in Fig. 4. ×125.
6. Corroded lower cuticle from a symmetrical broad laterally expanded leaf showing stomatal band (*sb*) and broad band of ordinary epidermal cells (*me*) over midrib and median area. Junction with upper cuticle was to right. Epidermal cells show obscure pits. ×55·5. V.32108*a*.
7. Part of stomatal band of same lower cuticle but from other side of median area in this leaf. Shows stomata arranged in close longitudinal lines and some elongate auxiliary cells. Reticulation of cell walls visible towards right and upper part of figure. ×215.

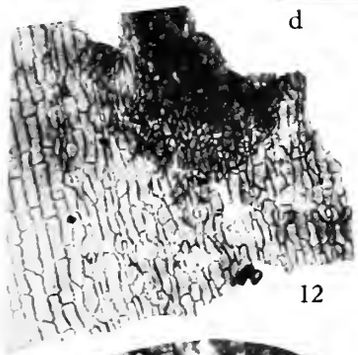
Fig.

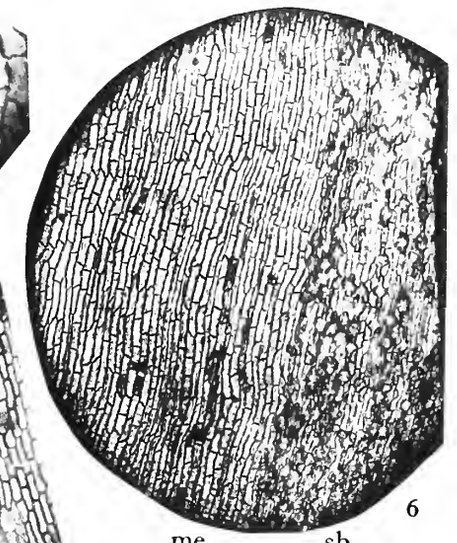
8. Upper cuticle from same leaf with highly characteristic ordinary epidermal cells and sparse stomata in lines. ×55·5. V.32108*a*.
9. Part of above. ×125 approx.
10. Lower cuticle from a symmetrical broad laterally expanded leaf showing stomatal band (*sb*) with close lines of stomata, and epidermal cell bands of midrib (left) (*lm*), and marginal area (right) (*ml*). ×100. V.43668.
11. Another fragment of lower cuticle from same leaf showing details of stomatal band of exceptionally well preserved cuticle. ×200.
12. Fragment of lower cuticle of laterally expanded leaf from twig named by Gardner *Sequoia tournali*. Shows part of epidermal band with highly characteristic cells on left at (*eb*) and a stomatal band with close lines of stomata, many with elongate polar auxiliary cells (cf. Figs. 7, 11). ×100. V.15103*b*.
13. Same, to show stomata. ×220.

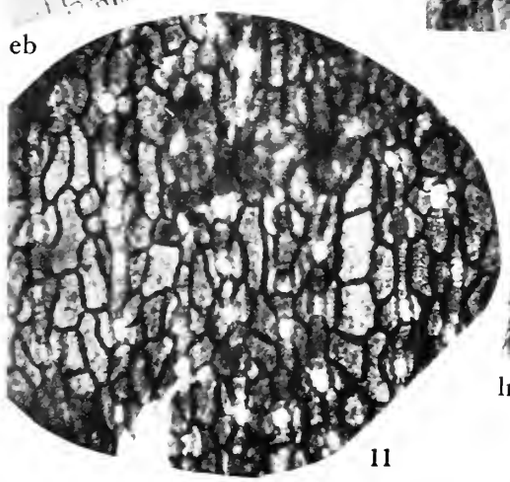
Figs. 1, 2 Sandbanks; Figs. 3–9 between Branksome and Canford Chines, Bournemouth; Figs. 10, 11 Branksome Dene; Figs. 12, 13 exact locality not known; all Bournemouth Freshwater Beds.

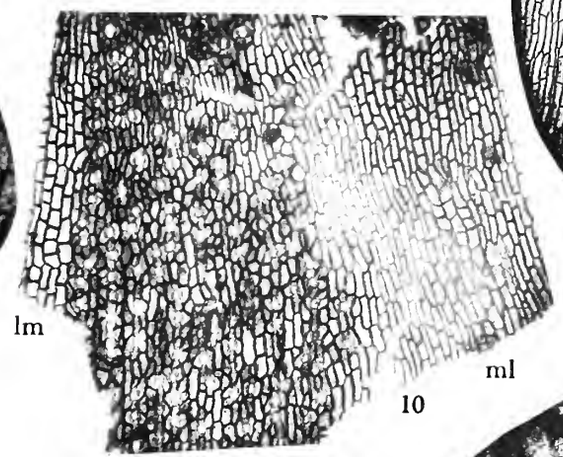


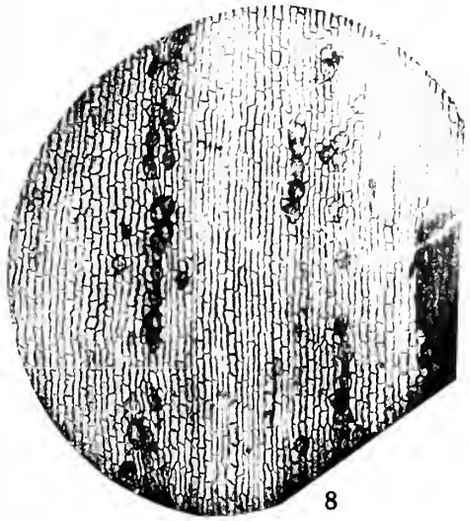


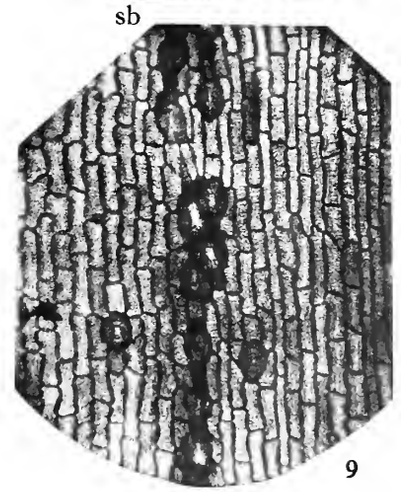


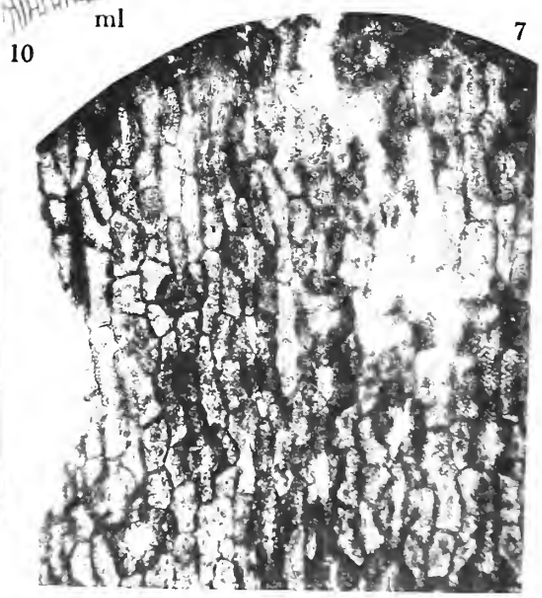












CUPRESSISTROBUS

Explanation of Plate 6

Fig.

Cupressistrobus gardneri Chandler p. 45

1. Cuticle from upper half of small median leaf on bifacial twig. Upper cuticle (*u*) on left with number of stomata in two bands separated by median band of epidermal cells. Extreme tip only of lower cuticle can be seen on right at (*l*). ×55·5. V.32108*c*.
2. Middle and lower part of lower cuticle of same small median leaf. Shows median epidermal cells between two stomatal bands and more numerous stomata towards base. Epidermal cells conspicuously pitted. ×55·5. V.32108*c*.
3. Part of upper cuticle in Fig. 1. An isolated stoma with guard cells clearly seen, as are epidermal cells of the median band. ×200.
4. Upper cuticle fragment from leaf in Plate 5, figs. 10, 11 showing stomata on left and varying shapes of epidermal cells on right. Line of stomata seen at (*l*). ×200. V.43668.
5. Lower cuticle fragment from imbricate twig named *Taxodium europaeum* by Gardner (cf. Bandulska, 1923, pl. 20, fig. 34; pl. 21, fig. 30). Pitted epidermal cells of median area occupy left two-thirds of figure. Among them is one rosette-like stoma. Part of stomatal band seen on right. ×110. V.15072*a*.

Fig.

6. Part of median epidermal cell band of above showing obscure pits and rosette-like stoma, stomatal band (*sb*) on right. ×220.
7. Part of same fragment showing upper end of stomatal band with lines and groups of stomata. ×220.
8. Scale from a male cone? Note curved tip and fringed margin on right. Stomata very few. ×209. V.43680.
9. Dorsal cuticle from decurrent leaf base showing thick-walled cells and small scattered stomata. ×185. V.43681.

Figs. 1–3 between Branksome and Canford Chines, Bournemouth; Fig. 4 Branksome Dene; Figs. 5–7 exact locality not known; all Bournemouth Freshwater Beds. Figs. 8, 9 Bournemouth Marine Beds just east of East Cliff lift, Bournemouth.

CUPRESSISTROBUS

Explanation of Plate 7

Fig.

Anemia subcretacea (Saporta) p. 37

1. Part of one of Gardner's typical barren pinnules showing toothed margin and repeated dichotomous nervation. ×6·5. V.15042.
2. A battered but comparable pinnule fragment, broken tip completed by an outline drawing. ×6·5. V.43689.

3, 4. Small fragments of barren pinnule. ×6·5. V.43690–91.

5–7. Fragmentary barren pinnules showing nervation. Fig. 6 is a pinnule tip. ×6·5. V.43693–94, original of Fig. 6 decayed.

Dicranopteris hantonensis (Wanklyn) p. 32

8. Sorus with ring of sporangia; impression with decayed remains only of carbonaceous tissue. ×15.
9. Two similar sori and a few detached sporangia (above). ×15.

Both above in Sedgwick Museum, Cambridge.

Pinus sp. p. 44

10. Fragment of pine needle, ventral surface showing median angle and lines of stomata. ×15·5. V.43684 (now incomplete.)
11. Same, rounded dorsal surface. Lines of stomata very clearly seen. ×15·5.
12. Fragment of larger needle, dorsal. ×15·5. V.43685 (now much decayed).
13. Same, ventral. ×15·5.

Araucarites sp. (?**A. sternbergi**) p. 40

14. Detached leaf. ×6·5. Decayed.

Sequoia couttsiae Heer p. 44

15. Much battered seed with curved seed body; (*st*) style. ×6·5. V.43687.
16. Minute but typical twig fragment. ×6·5. Decayed.

Potamogeton pygmaeus Chandler p. 60

17. Much abraded endocarp with seed partly exposed. ×15. V.43103.
18. Endocarp with spiny keel (*k*) just beginning to open, and remains of style (*st*). ×15·5. V.43104.
19. Much battered endocarp, keel at (*k*). ×15·5. V.43105.
20. Small non-spiny endocarp showing style and a fragment of keel. ×15·5. V.43106.
21. Another much abraded and somewhat distorted specimen; keel not preserved. ×15·5. V.43107.

Limnocarpus forbesi (Heer) p. 61

22. Endocarp turned to show dorsal margin from which germination valve has gone exposing the locule. (*s*) style. ×15. V.43119.
23. Endocarp showing rugose external surface, large foramen and style (*s*). Germination valve towards left. Base of endocarp broken. ×15·5. V.43120.
24. Another. (*s*) style, keel to left. ×15·5. Decayed.
25. One valve of endocarp, broken at base, showing foramen. (*s*) style. ×15·5. V.43126.
26. Detached germination valve, external surface showing median ridge. ×15·5. V.43127.

Fig.

?Alisma sp. p. 61

27, 28. Opposite surfaces of fruit, slightly imperfect on dorsal margin towards upper end. ×15. V.43509.

Stratiotes minutissimus n. sp. p. 63

29, 30. Holotype, seed. Outside and inside of single valve, showing external ribbing and on inner side the raphe. ×15. V.43130.

31. Dorsilateral view of typical seed, keel to left. ×15. V.43132.
32. Long narrow seed. ×15. V.43131.
33. Dorsal view of another seed showing suture at edge of keel. It has begun to gape. ×15. V.43134.
34. Dorsiventrally compressed seed, dorsal view, showing keel and collar. ×15. V.43133.

35, 36. Exterior (Fig. 35) and interior (Fig. 36) of somewhat crushed and broken seed. External ribbed surface can be seen. On internal surface longitudinal striations due to tegmen cells are visible. ×15. V.43135.

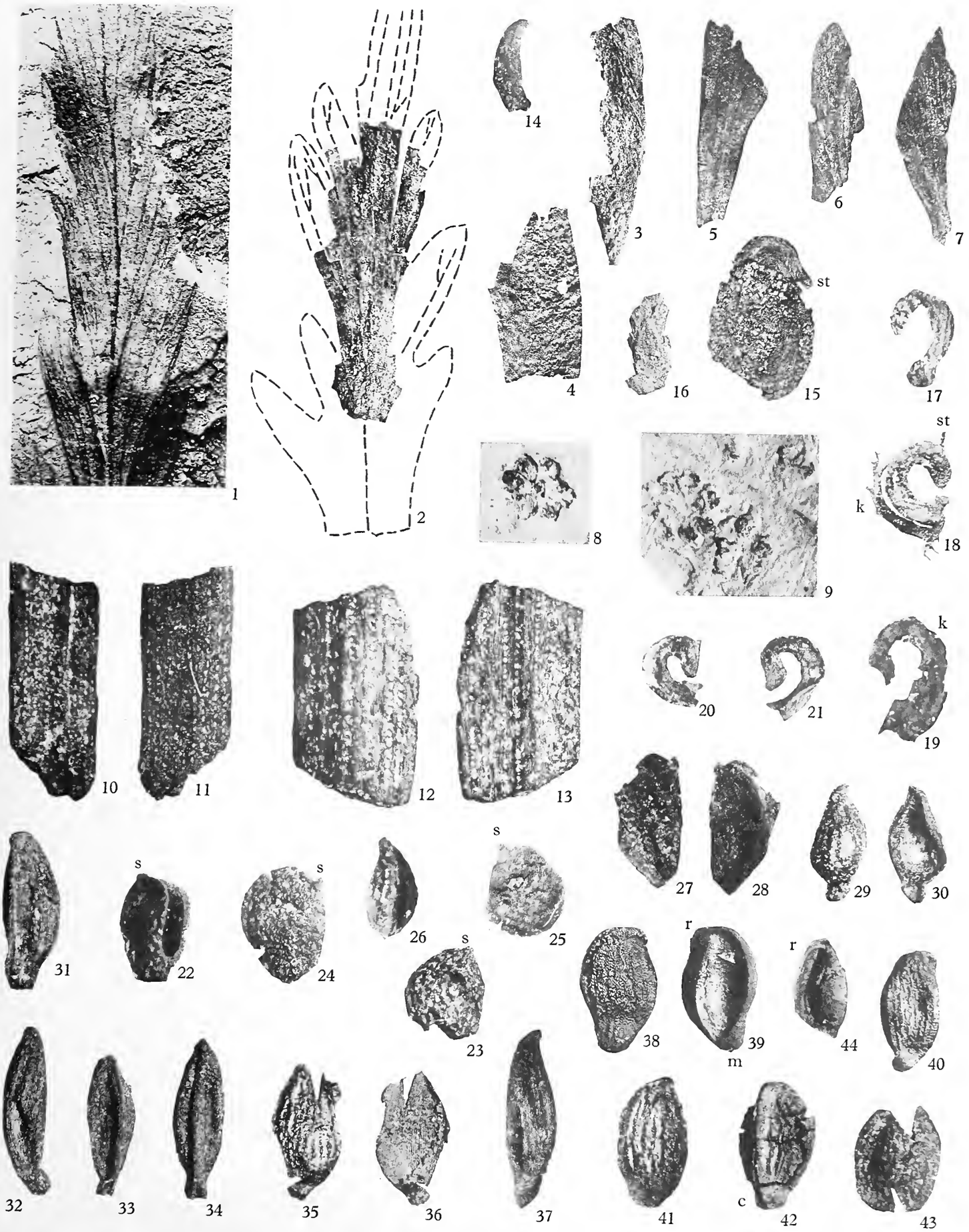
37. Typical sigmoidal seed. ×15. Decayed.

Stratiotes hantonensis Chandler p. 62

38, 39. Holotype. Valve of relatively unworn seed, exterior (Fig. 38) with longitudinal ribs and pits; interior (Fig. 39) with micropyle (*m*) and short transverse raphe canal (*r*). Tegmen is seen adhering to inner surface of testa. ×8. V.36484.

40. Perfect but somewhat abraded seed showing sigmoidal form, ridges and rounded basal collar. ×8. V.43147.
41. Much abraded seed. ×8. V.43138.
42. Seed looking onto keel, two valves beginning to separate. (*c*) collar. ×8. V.43139.
43. External surface of valve of another seed. Irregular longitudinal splitting seen at apex and base is caused by contraction on drying. ×8. V.43140.
44. Imperfect valve of seed, inner surface, showing chalazal end of raphe canal (*r*) truncated at left-hand margin of seed by abrasion. ×8. V.43141.

Figs. 1–4, 8, 9, 14–17, 27–37, 41 Bournemouth Freshwater Beds: Figs. 2–4, 17 Branksome Dene; Figs. 8, 9 below Highcliff Mansions, Bournemouth; Figs. 14, 15, 27–37 Sandbanks; Fig. 16 between Alum and Middle Chines and Fig. 41 between Middle and Durley Chines, Bournemouth. Figs. 10–13, 20, 21, 25, 26 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 18, 38–40, 42–44 Bournemouth Marine Beds: Figs. 18, 38–40 dark sands, cliff base, Southbourne; Figs. 42–44 Marine Sands, just east of East Cliff lift, Bournemouth. Figs. 19, 24 Lignite above Boscombe Sands; Figs. 22, 23 carbonaceous lenticle, base of Boscombe Sands, Southbourne. Figs. 5–7 Dorset Pipe-clay Series, Studland, for comparison.



ANEMIA, DICRANOPTERIS, PINUS, ARAUCARITES, SEQUOIA, POTAMOGETON, LIMNOCARPUS, ALISMA, STRATIOTES

Explanation of Plate 8

Fig.

Stratiotes hantonensis Chandler p. 62

1, 2. Two valves of single seed. Fig. 1 external surface of one valve, Fig. 2 internal surface of other. (*r*) raphe canal, (*m*) micropylar canal. ×7. V.43144.
3. Valve of seed, external surface; (*c*) collar; (*k*) keel. ×6·5. V.43148.
4. Same, inner surface showing long raphe (left). Crumpled tegmen lies within cavity of seed. ×6·5.
5. Valve of seed, external surface; (*c*) collar; (*h*) hilum. ×6·5. V.43149.
6. Same, inner surface, showing transverse upper end of raphe; (*c*) collar; (*h*) hilum. ×6·5.
7. Valve of another seed, external surface; (*k*) keel; (*c*) collar. ×6·5. V.43152.
8. Valve of seed, external surface; (*c*) collar; (*k*) keel. ×6·5 V.43151.
9. Same, inner surface, (*r*) short reflexed raphe. ×6·5.
10. Small narrow valve (? immature and abortive), external surface. Projection, (*h*) marks hilum and short raphe. ×6·5. V.43155.
11. Valve of broad short seed, external surface showing rugosities clearly. ×6·5. V.43156.
12. Same, inner surface, showing broad keel with long marginal raphe (*r*) and micropyle (*m*). ×6·5.
13. Large complete seed, dorsal, showing valves beginning to gape along edge of keel. ×6·5. V.43157.
14. Valve of seed, exterior, with well marked keel (*k*) and collar (*c*). ×6·5. V.43158.
15. Short broad seed with very rugose surface; (*k*) keel; (*c*) collar. ×6·5. V.43159.
16. Long narrow seed, exterior; (*c*) collar. Limits of keel ill-defined externally. ×8. V.43162.
17. Seed. ×8. V.43163.
18. Crushed, somewhat sigmoidal seed. ×8. V.43164.
19. Valve of seed, external surface, showing sigmoidal form; (*h*) hilum, (*c*) collar. ×8. V.43165.
20. Same, internal surface, showing short raphe passing directly across keel to hilum (*h*). ×8.
21. Another valve, external surface, with conspicuous collar. ×8. V.43166.
22. Same, internal surface. ×8.
23. Seed, external surface. ×8. V.43167.
24. Valve of markedly sigmoidal seed, internal surface showing narrow keel, reflexed raphe and hilum at (*h*). (*c*) collar traversed by micropyle. ×8. V.43169.
25. Valve, internal surface, showing marginal raphe. ×8. V.43168.
26. Small somewhat abraded valve, external surface, with broad smooth keel (*k*) and collar (*c*). ×8. V.43177.
27. Same, internal surface. Marginal raphe on extreme right. ×8.
28. Large somewhat abraded seed with well differentiated collar. Keel on right. ×8. V.43178.
29. Much abraded valve with typical form, conspicuous keel (*k*) and smoothly rounded collar (*c*). ×8. V.43179.
30. Same, inner surface, showing broad keel (right) with raphe marginal to hilum at (*h*). ×8.
31. Typical seed, collar at (*c*), keel on right. ×8. V.43181.
32. Much flattened and abraded seed beginning to crack. ×8. V.43180.

Fig.

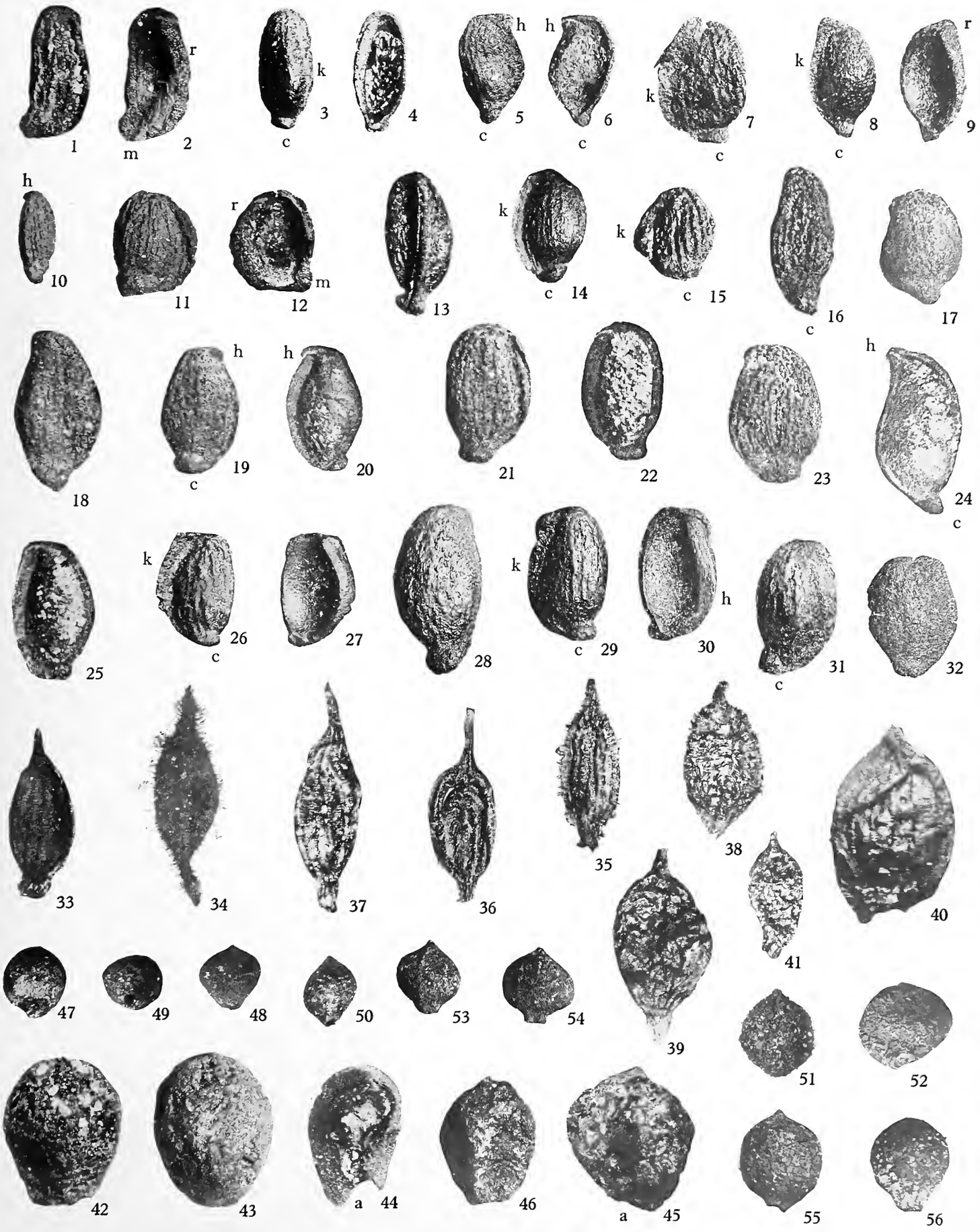
Scirpus lakensis Chandler p. 65

33. Fruit with outer coat abraded so that internal shining coat is exposed with regular longitudinal rows of transversely elongate cells. ×15. (By transmitted light.) V.43188.
34. Another more abraded so that thicker parts of wall are frayed thereby producing a "fringe" along all cell margins. ×15. (By transmitted light). V.43188.
35. Similar specimen showing "fringe". ×15. (By reflected light.) V.43188.
36. Another further abraded so that much of "fringe" has been removed. ×15. (By reflected light.) V.43189.
37. Another showing transversely elongate cells arranged in regular longitudinal rows very clearly. ×15. V.43193.
38. Another showing "fringe" of frayed cell wall. ×15. V.43194.
39. Much battered fruit, innermost layers only. ×15. V.43199.
40. Much abraded specimen with style and base broken. ×28. V.43498.
41. Another fruit battered but more perfect at base and apex. ×15. V.43202.

Caricoidea obscura Chandler p. 65

42. Fruit, exterior showing truncate base due to large aperture. ×15. (White spots due to adhering sand grains.) V.43203.
43. Another. ×15. V.43204.
44. Fruit, fractured longitudinally, showing thick corky substance which encloses a distorted oburceolate nut. Also basal canal and aperture (*a*) can be seen. ×15. V.43205.
45. Fruit slightly tilted to expose basal aperture at (*a*). ×15·5. V.43206.
46. Small somewhat abraded specimen, probably this species. ×15·5. V.43207.
47. Endocarp with ribs, tilted to show basal neck. ×15·5. V.43208.
48. A smooth endocarp without longitudinal ribs. ×15·5. V.43209.
49. Same, base, to show aperture at end of neck. × 15·5.
50. Another narrower specimen with ribs. ×15·5. Decayed.
51. Much decayed endocarp. × 15. Decayed.
52. Endocarp tilted to show basal foramen. This species or *C. angulata*? ×15. V.43217.
53. Endocarp with longitudinal ribs and well-defined neck possibly this species. ×15. V.43215.
54. Similar specimen. ×15. V.43216.
55, 56. Two somewhat larger endocarps. ×15. Both decayed.

Figs. 1–9, 51 Bournemouth Marine Beds: Figs. 1, 2 Honeycomb Chine, Boscombe; Figs. 3–9 Leafy lenticle, cliff base, Southbourne; Fig. 45 just east of East Cliff lift, Bournemouth; Fig. 51 dark sands, cliff base, Southbourne. Figs. 10–15, 52 carbonaceous lenticle, base of Boscombe Sands, Southbourne; Figs. 16–25, 46 Lignite above Boscombe Sands, Southbourne. Figs. 26–30, 32, 47–50, 53–56 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford; Fig. 31 coarse sand in foreshore at edge of "the Run" below cliff, Cliff End. Figs. 33–39, 42–44 Bournemouth Freshwater Beds: Figs. 33–36, 42–44 Sandbanks, Figs. 33–36 Simpsons' Folly; Figs. 37, 38 Branksome Dene; Fig. 39 between Middle and Durley Chines, Bournemouth. Figs. 40, 41 Bracklesham Beds, Alum Bay, Isle of Wight.



STRATIOTES, SCIRPUS, CARICOIDEA

Explanation of Plate 9

Fig.

Caricoidea angulata n. sp. p. 66

1. Holotype, fruit with utricle preserved. Base truncate by aperture, apex abraded. ×15. V.43218.
2. Pair of fruits (*a*, *b*) in utricles adherent as in life indicating mode of growth in a spike. ×6·5. V.43219.
3. Fruit in utricle with apex preserved showing stylar mucro. ×6·5. V.43220.
4. Fruit sectioned tangentially-longitudinally through thick corky layer so that enclosed endocarp (*e*) is partly exposed ×15. V.43222.
5. Broad flat fruit with stylar mucro and basal aperture at (*a*). ×15. V.43221.
6. Fruit in utricle with an adherent fragment of leaf or bract on right at (*b*) its surface somewhat rough with low rounded tubercles. ×15. V.43223.
7. Another typical fruit. ×15. V.43224.
8. Endocarp detached from its utricle, tilted to show basal aperture (*a*) filled with sand. ×15. V.43225.
9. Another with style (*st*) tilted to show basal aperture (*a*) crushed, so that it appears bilobed. ×15. V.43226.
10. Endocarp, side, with adherent remains of utricle (*u*). Basal aperture (*a*) truncates outline. ×15. V.43227.
11. Fruit in utricle. ×15. V.43235.
12. Another narrower specimen. ×15. V.43236.
13. Short fruit with obliquely truncated apex, tilted to show conspicuous basal aperture (filled with white sand). ×15. V.43237.
14. Fruit, abraded below so that enclosed endocarp (*e*) is exposed. It rests on flattened apex so as to show basal aperture. ×15·5. V.43239.
15. Fruit with endocarp partly exposed by abrasion of fruit wall on this side. Basal aperture at (*a*). ×15·5. V.43240.
16. Fruit much compressed and sand pitted. ×15·5. V.43242.
17. Smaller crushed fruit. Concavity at base marks basal aperture (*a*). ×15·5. V.43243.
18. Flat-topped fruit, distorted endocarp being exposed in longitudinal section; (*a*) basal aperture. ×15. Decayed.
19. Endocarp protruding from remains of fruit which adheres round base. ×15·5. Decayed.
20. Detached endocarp. ×15·5. Decayed.
21. Another endocarp. ×15·5. Decayed.
22. Small immature fruit, possibly this species. ×15·5. V.43241.
23. Detached crushed endocarp, perhaps immature. ×15·5. V.43245.

Caricoidea sp. p. 68

24. Another endocarp with scarcely mucronate apex, conspicuous basal neck closed by a plug (*p*) and pitted surface. × 15·5. V.43248.

Fig.

Scleriocarya tribrachteata n. gen. & sp. p. 68

25. Holotype. Endocarp, side, showing one remaining basal bract (*b*) sectioned longitudinally. ×15. V.43249.
26. Same, base, showing large basal foramen and incomplete remaining bract at (*b*). ×15.
27. Same, apex; (*b*) bract. ×6·5.

Cladiocarya foveolata Reid & Chandler p. 69

28. Oburceolate endocarp with conspicuous apical mucro, short truncate basal neck, pitted surface. Figure shows one of the two longitudinal ridges which mark a plane of symmetry. ×15. V.43250.
29. Same at right angles to preceding. ×15.

Calamus daemonorops (Unger) p. 70

30. Spine base with short remains of a broken spine in centre. ×6·5. V.43251.
31. Another with longer remains of one spine and extreme lower end of a second on left. ×6·5. V.43252.
32. Base with remains of three spines (one only clearly seen in photograph). ×6·5. V.43253.
33. Spine base, all spines broken. ×2·8. V.43254.
34. Very small specimen with single spine. ×2·8. V.43255.

Palmospermum sp. p. 70

35. Much compressed seed showing hilar-chalazal scar on left (*sc*). ×15·5. V.43256.
36. Same, opposite side, showing network of meshes and grooves indicating ruminations. ×15·5.

Figs. 1–13, 30–32 Bournemouth Freshwater Beds: Figs. 1–10 Sandbanks; Figs. 11–13, 30–32 Branksome Dene. Figs. 14, 15, 22, 23 Bournemouth Marine Beds: Fig. 14 Marine Sands, just east of East Cliff lift, Bournemouth; Fig. 15 dark sands, cliff base, Southbourne; Figs. 22, 23 Leafy lenticle, cliff base, Southbourne. Figs. 16–21, 24, 35, 36 Lignite above Boscombe Sands, Southbourne. Figs. 25–27 coarse sand, foreshore, edge of "the Run", below cliff, Cliff End, Mudeford; Figs. 28, 29, 33, 34 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.

CARICOIDEA, SCLERIOCARYA, CLADIOCARYA, CALAMUS, PALMOSPERMUM

Explanation of Plate 10

Fig.

Nipa burtini (Brongniart) p. 72

1. Apex of fruit. Longitudinal fibrovascular bundles seen as impressions on sandy cast. ×1 approx. V.43072.
2. Another fruit, slightly imperfect at apex, broken below to expose part of seed (*s*). ×1 approx. V.43073.
3. Apex of another smaller specimen showing more clearly impressions of longitudinal fibres. ×1 approx. V.43074.
4. Base of fruit. ×1 approx. V.43075.
5. Seed-cast with adherent remains of fruit on left. ×1 approx. V.43077.
6. Flattened seed-cast. ×1 approx. V.43076.
7. Seed-cast imperfect on left. ×1 approx. V.43078.

Sabal sp. p. 71

8. Fragment of decayed leaf, upper surface. Inner ends of pinnae can be seen but central part of leaf abraded and obscure. ×6·5. Decayed.
9. Opposite side of same fragment showing central part of rachis. ×6·5.
10. Fragment from central part of leaf, upper surface, showing upstanding edges of ligule (*l*, *l*). ×6·5. Decayed.
11. Fragment of leaf showing pinnae arising on both sides of axis. ×2·9. Decayed.
12. Fragment of leaf, upper surface. Leaf broken along axis, pinnae seen on left and part of abraded ligule (or axis?) in lower part of figure on right. ×2·9. Decayed.
13. Same, lower surface, pinnules arise from a fragment of axis on left. ×2·9.

Fig.

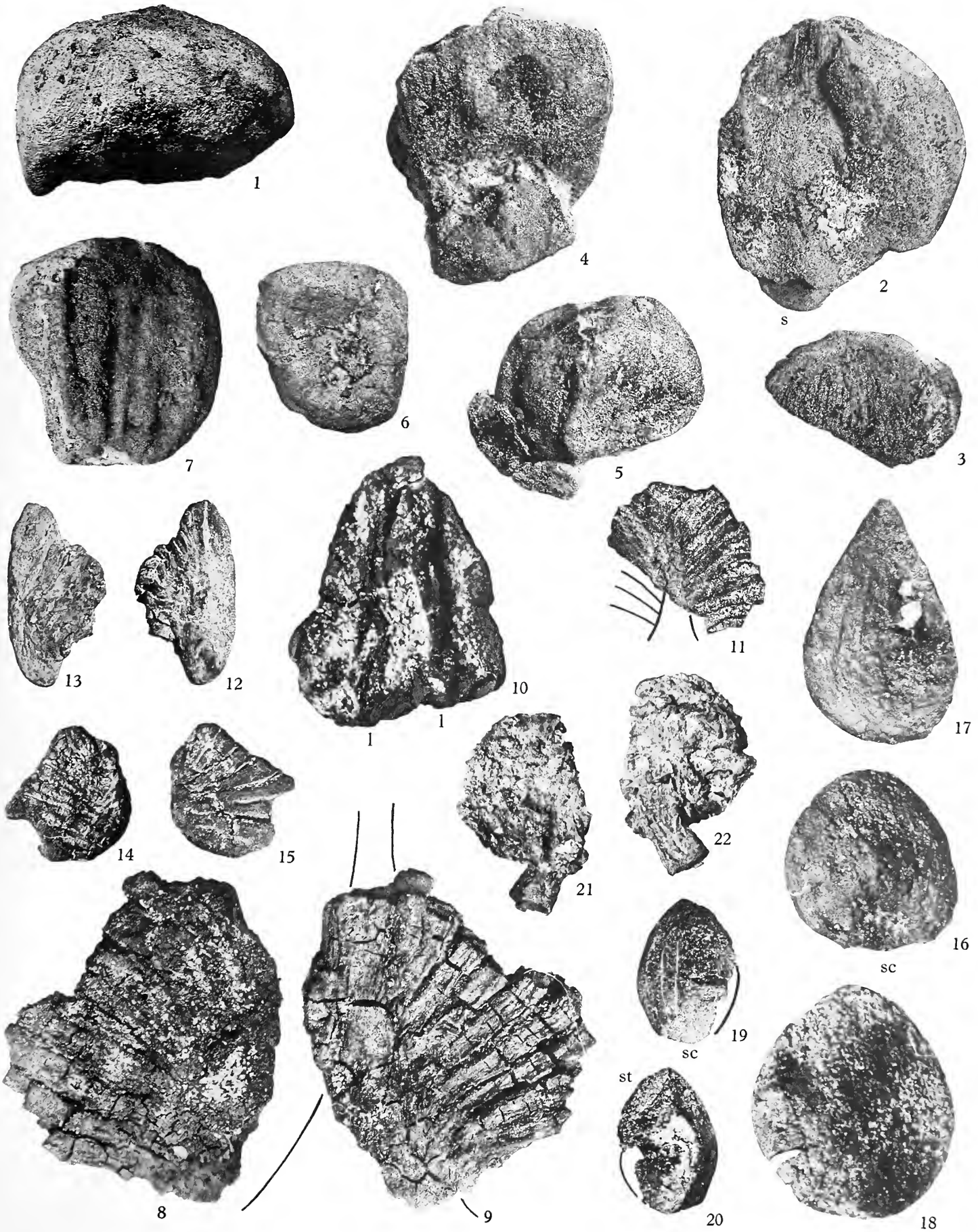
14. Central part of leaf, lower surface, showing broadening of rachis; pinnae bases on the left. ×2·9. Decayed.
15. Opposite surface. ×2·9.

Carpinus boveyanus (Heer) p. 73

16. Abraded fruit showing basal scar of attachment (*sc*) and longitudinal fibres in accrescent calyx. ×15·5. V.43257.
17. Narrow triangular fruit. ×15·5. V.43258.
18. Much abraded valve of fruit. ×15·5. V.43261.
19. Imperfect fruit showing furrows in abraded adherent calyx formerly occupied by fibres; (*sc*) is large basal scar of attachment. ×8·5. V.43260.
20. Same, opposite side. Part of second fruit valve still adheres on right. It has broken away on left exposing inner surface of first valve with its broad marginal suture (*st*) and apical canal. ×8·5.

Alnus poolensis n. sp. p. 74

21, 22. Holotype. Opposite sides of distorted cone showing stalk and scales. In Fig. 22 lower end of cone exposed by distortion and in Fig. 21 the upper end. ×6·5. V.43263. Figs. 1–7, 16 Bournemouth Marine Beds: Figs. 1–7 Honeycomb Chine, Boscombe; Fig. 16 Leafy lenticle, cliff base, Southbourne. Figs. 8–17 Lignite above Boscombe Sands, Southbourne. Figs. 18–20 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 21, 22 Bournemouth Freshwater Beds, Sandbanks.



NIPA, SABAL, CARPINUS, ALNUS

Explanation of Plate 11

Fig.

Alnus poolensis n. sp. p. 74

1. Cone-scale from cone in Pl. 10, figs. 21, 22, lower surface showing umbo. ×15.
2. Another scale, lower surface. ×15.
3. Another, upper surface. ×15.

4–7. Fruits, showing two styles. ×15. V.43264, V.43265–67.

8. Cone fractured obliquely and transversely; axis seen in section, a few scales and long peduncle preserved. At (*s*) is impression of lower surface of a scale with part of scale itself (upper surface exposed) at distal four-lobed end. ×6·5. V.43268.

Morus poolensis n. sp. p. 76

9. Holotype. Endocarp, exterior, (*p*) position of placenta. ×15. V.43269.
10. Same, interior of valve, (*p*) position of placenta; (*f*) funicle remains; (*s*) adherent edge of seed. ×15.
11. Another, exterior (broken in half diagonally). (*p*) placenta. ×15. V.43270.
12. Same, interior, (*p*) placenta; (*ch*) hollow due to chalaza. ×15.

Ficus lucidus Chandler p. 76

13. Much compressed carpel. ×15. V.43271.

14, 15. Two others. ×15. V.43272–73.

Becktonia hantonensis Chandler p. 77

16. Endocarp looking onto one of subtriangular faces. (*f*) foramen for funicle. ×8·5. V.43274.
17. Same, looking onto one of three angles. Specimen tilted to show subterminal oblique aperture for funicle (*f*). ×8·5
18. Same, apex, showing three angles and small oblique aperture for funicle. ×8·5.
19. Same, fractured longitudinally through funicular aperture (at top of figure) and subjacent placenta. ×8·5.
20. Endocarp, somewhat collapsed, side; (*f*) foramen for funicle. ×6·5. V.43275.
21. Same, apex, showing foramen (filled with white sand grains). ×6·5.
22. Somewhat crushed endocarp (since dissected on one side to show locule). ×6·5. V.43504.

Moraceae. Genus? p. 77

23, 24. Opposite sides of same fruit; (*p*) indicates position of style and placenta. ×15. V.43276.

25. Similar but much battered and compressed specimen showing more clearly apical plug (*p*) associated with placenta and style.(White spots are sand grains embedded in specimen). ×15. V.43278.

26, 27. Very immature carpel? (opposite sides). ×15. V.43277.

Fig.

Hantsia pulchra (Chandler) p. 78

28. Ventral margin of seed showing extremities of limbs and hilar aperture between them. Greater part of seed broken away. ×15·5. Decayed.
29. Much crushed seed showing hilar aperture (*h*). On dorsal margin crushing has exposed testa in section; (*m*) micropylar limb. ×15·5. Decayed.
30. Part of another seed showing rimmed hilum (*h*) and micropylar limb (*m*). Other limb and dorsal margin imperfect. ×15·5. Decayed.
31. Much crushed and broken seed with coarse tubercles. Shows hilar region but aperture with rim obscure. ×15·5. V.43280.
32. Crushed seed broken along dorsal margin. Shows finer tubercles. Hilum and parts of two limbs are seen. ×15·5. V.43281.
33. Fragment of seed near hilum. Shows digitate tubercles (clear in actual specimen). ×15·5. V.43279.
34. Small somewhat crushed seed. ×15·5. V.43282.

35–37. Three fragments of seeds. Fig. 35 (V.43283) from hilar part of seed. Fig. 36 (V.43285), Fig. 37 (V.43284) from margin. ×15·5.

Brasenia ovula (Brongniart) p. 79

38. Seed (splitting longitudinally) showing columnar structure along fractured edge of testa. Inside testa an integument with polygonal cells exposed. (*e*) aperture for embryotega. ×15·5. V.43286.
39. Seed, side (now cracking). ×15·5. V.43287.
40. Another seed, distorted and crushed so as to display aperture for embryotega. ×15·5. V.43289.

41, 42. Fragment of testa abutting on embryotega at (*e*). Fig. 41 external surface with digitate cells. ×15·5. Fig. 42 internal surface. ×20. V. 43290.

Figs. 1–27 Bournemouth Freshwater Beds: Figs. 7, 15, 25 Branksome Dene; Fig. 8 exact locality not known; Figs. 1–6, 9–14, 20–24, 26, 27 Sandbanks; Figs. 16–19 between Alum and Durley Chines, Bournemouth. Figs. 28–32, 40 Lignite above Boscombe Sands, Southbourne. Figs. 33, 34, 38, 39 Bournemouth Marine Beds: Fig. 33 Leafy lenticle, cliff base, Southbourne; Fig. 34 Marine Sands, just east of East Cliff lift, Bournemouth; Fig. 38 dark sands, cliff base, Southbourne; Fig. 39 Honeycomb Chine, Boscombe. Figs. 35–37, 41, 42 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.

ALNUS, MORUS, FICUS, BECKTONIA, MORACEAE GENUS (?),HANTSIA, BRASENIA

Explanation of Plate 12

Fig.

Palaeonymphaea eocenica Chandler p. 79

1. Small seed crushed and distorted so that surface of embryotega brought into view. (*r*) raphe; (*e*) embryotega, bearing rimmed hilum, separating from seed body. ×15. V.43294.
2. Seed showing aperture (*a*) once occupied by embryotega. (*r*) raphe; (*ch*) chalaza indicated externally by irregular tubercles or nodulations. ×15. V.43295.
3. Another, much sand-pitted. Line across aperture for embryotega marks edge of tegmen which has torn away from testa inside. ×15. V.43296.
4. Another, showing embryotega coming away. ×15. V.43297.
5. Seed with embryotega clearly displayed; raphe ridge (longitudinal, median) clearly seen; (*h*) rimmed hilum. ×15. V.43299.
6. Crushed seed with rimmed hilum (*h*). ×15. V.43300.

Nymphaeaceae. Genera? p. 80

7. Cracked seed, one longitudinal half only, external surface. (*a*) aperture for embryotega, not preserved. ×15. V.43303.
8. Same, inner surface. Oblique line near apex accidental not structural, due to compression of seed. ×15.
9. Seed of a second genus (p. 81), aperture for embryotega seen in profile at top. ×15. V.43304.

Palaeosinomenium hantonense n. sp. p. 82

10. Holotype. Endocarp with typical curved form. Elongate foramen seen (white) between limbs. ×6·5. V.43306.
11. Opposite side of same; (*m*) stylar and micropylar limb. ×6·5.

Palaeosinomenium spp. p. 83

12. Imperfect endocarp represented by part of two still adherent valves. It shows flat slightly fluted marginal area, stylar arm of raised horse-shoe shaped ridge grooved along its crest and narrow elongate foramen near ventral margin. ×15. V.43307.
13. Same, opposite side, surface of other valve. ×6·5.
14. Valve of endocarp of a second species, slightly imperfect at base, external surface. Specimen broken obliquely. ×15·5. V.43308.
15. Same, internal surface, showing broad marginal suture and two limbs. ×15·5.

Fig.

Palaeococculus lakensis Chandler p. 81

16. Fragment of endocarp, to left of crack, external surface, showing smooth, broad marginal area and band of radial ridges. To right part of another endocarp (V.40459) from Lake has been placed to show relationship of fragment to a typical specimen. ×15·5. V.43305.

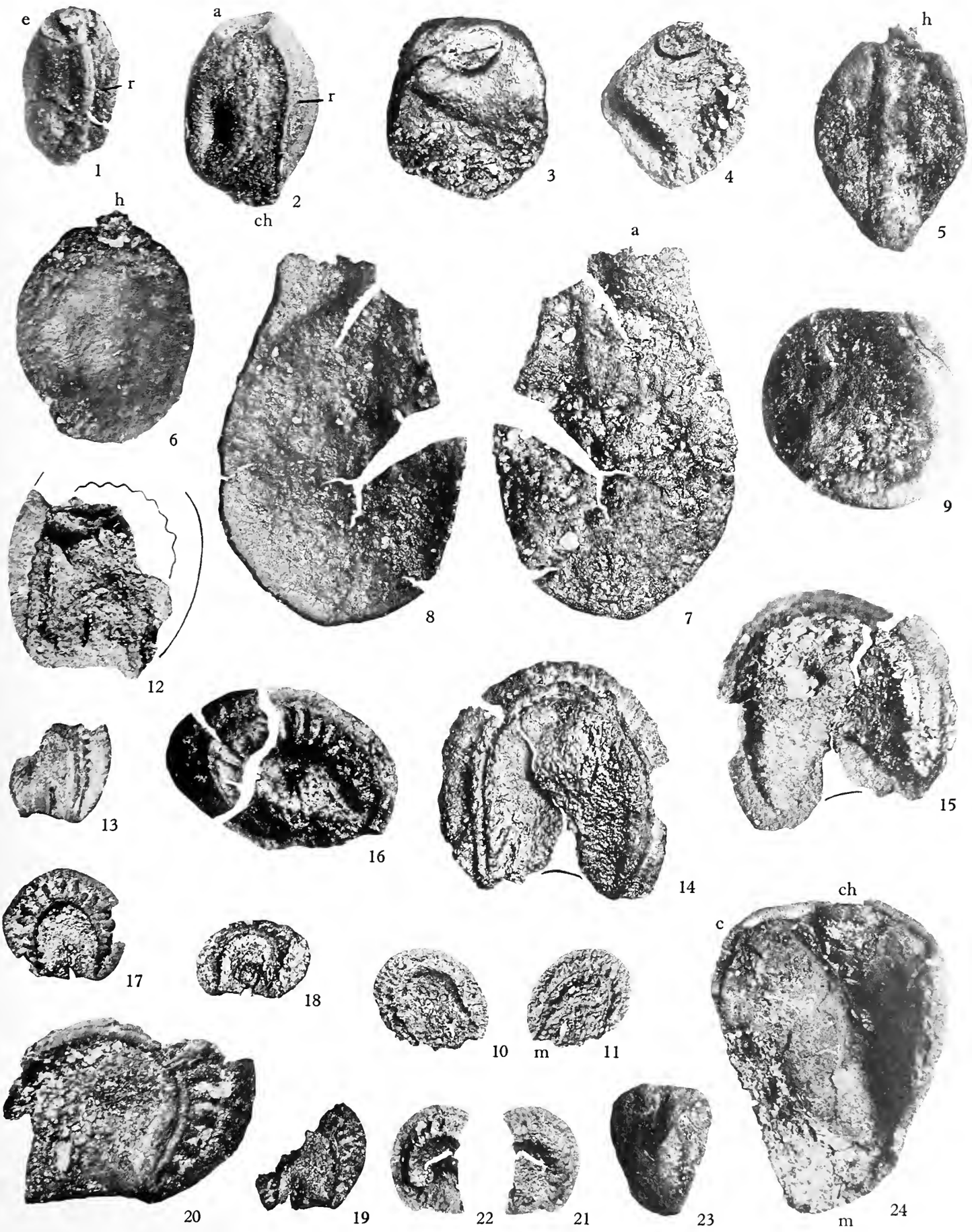
Wardenia marginata n. sp. p. 84

17. Holotype. Almost perfect endocarp, broken only in two small places on margin. ×6·5. V.43309.
18. Distorted endocarp. ×6·5. V.43310.
19. Imperfect endocarp with tip of one limb and whole of other preserved. It shows the elongate foramen near the ventral margin. ×6·5. V.43311.
20. Imperfect endocarp showing median sunk area between arms of horse-shoe and end of one limb. Elongate foramen near missing limb and ventral margin is clear (filled with white sand). ×15·5. V.43312.
21. Half a valve of an endocarp, external surface, stylar limb missing. ×6·5. V.43314.
22. Same, inner surface (lighting causes concave cavity to appear convex). ×6·5.

Magnolia sp. (**?M. angusta** Reid & Chandler) p. 85

23. Half a seed split longitudinally, external surface. ×6.5. V.43316.
24. Same, internal surface; (*ch*) chalaza; (*m*) micropylar end. Columnar testa seen in section at (*c*). ×15.

Figs. 1–11, 23, 24 Bournemouth Freshwater Beds: Figs. 1–4, 10, 11, 23, 24 Sandbanks; Figs. 5–8 Branksome Dene; Fig. 9 behind broken promenade, between Alum Chine and Branksome Dene, Bournemouth. Figs. 16, 21, 22 Bournemouth Marine Beds: Fig. 16 Honeycomb Chine, Boscombe; Figs. 21, 22 Leafy lenticle, cliff base, Southbourne. Figs .17–20 Lignite above Boscombe Sands, Southbourne. Figs. 12–15 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.



PALAEONYMPHAEA, NYMPHAEACEAE GENUS (?), PALAEOSINOMENIUM, PALAEOCOCCULUS, WARDENIA, MAGNOLIA

Explanation of Plate 13

Fig.

Anonaspermum sp. p. 86

1. Incomplete valve of seed, external surface; (*h*) hilum. ×6·5. V.43317.
2. Same, internal surface showing tag-like projections which penetrated into ruminations of albumen. ×15·5.

Cinnamomum sp. p. 87

3. Crushed berry showing basal attachment scar (*s*). ×6·5. V.43318.
4. Similar berry slightly imperfect on right side of attachment scar (*s*). ×6·5. V.43319.

Laurocarpum spp. p. 87

5. Curved and deformed pericarp of berry. ×2·8. V.43321.
6. Internal cast of above preserved in fine sandy matrix. It shows impression of raphe fibres. ×2·8.
7. Larger berry with small attachment scar (*a*). ×15·5. V.43325.
8. Berry with epicarp decayed over most of surface. Small cupule preserved. ×15·5. V.43324.
9. Small, perhaps immature, crushed berry. ×15·5. V.43323.
10. Fragment of large berry, margin at (*m*). ×15·5. V.43326.
11. Berry. ×15·5. V.43328.

Capparidispermum poolense n. sp. p. 88

12. Holotype. Seed showing curved form and separation of two limbs at hilum (*h*). Regular concentric alignment of coarsely pitted integument seen. ×15. V.43329.
13. Another, broken into two symmetrical valves, inner surface showing clearly the separation of two limbs. Chalazal limb distorted and incomplete; (*m*) micropyle. ×15. V.43330.

Fig.

14. Another seed with limbs separating. Longer, micropylar, limb broken exposing seed cavity at (*sc*). ×15. V.43331.
15. Another seed showing two limbs, pitted integument and remains of an outer coat in places. Tip of micropylar limb broken. ×15. V.43332.
16. Seed with much of outer coat preserved. Chalaza limb (right) is broken. ×15. V.43333.

Protoaltingia hantonensis Chandler p. 89

17. Much abraded fruiting head. ×6·5. V.43339.
18. Fragment of fruiting head. Specimen shows two loculed endocarps (*e*) splitting loculicidally in some of the alveolae. ×6·5. V.43340.
19. Imperfect somewhat abraded head showing gaping two-loculed endocarps and antero-posterior arrangement of locules. ×6·5. V.43341.
20. Somewhat abraded fruiting head, broken obliquely at distal end. It shows a pair of locules (*l*, *l*) in a fruitlet and many areoles from which other fruitlets have fallen. ×6·5. V.43335.

Figs. 1–6, 12–16, 20 Bournemouth Freshwater Beds: Figs. 1–4 Branksome Dene; Figs. 5, 6 between Branksome and Canford Chines; Figs. 12–16, 20 Sandbanks. Figs. 11, 19 Lignite above Boscombe Sands, Southbourne. Figs. 7–10, 18 Leafy lenticle, cliff base, Southbourne; Fig. 17 Honeycomb Chine, Boscombe; all Bournemouth Marine Beds.

ANONASPERMUM, CINNAMOMUM, LAUROCARPUM, CAPPARIDISPERMUM, PROTOALTINGIA

Explanation of Plate 14

Fig.

Protoaltingia hantonensis Chandler p. 89

1. Fragment of abraded fruiting head with immature fruitlets showing four-partite distal end and evidence of loculicidal splitting. ×6·5. V.43342.
2. Abraded fruiting head showing numerous areoles with dehisced fruitlets and spiral arrangement on axis. ×6·5. V.43343.
3. Abraded head showing gaping two-loculed loculicidal endocarps in areoles. ×6·5. V.43344.

Hamamelidaceae. Genus? p. 90

4. Carpel (outer surface) still attached to peduncle bearing scars of leaves (or bracts? or other fruits?). One of a pair of carpels, the other having broken in fossilization. ×15. V.43350.
5. Same, inner surface. ×15.
6. Detached endocarp, looking onto plane of septicidal dehiscence. Shows beginning of loculicidal splitting. ×15. V.43351.
7. Another, loculicidal dehiscence further advanced. ×15. V.43352.
8. Another, much compressed and broken. ×15. V.43353.

Rubus acutiformis Chandler p. 90

9–22. Endocarps showing variations of form and size. ×15. V.20057–58, V.43354–58, V.43362–63, V.43368–69.

Leguminosae? Genus? p. 91

23. Broken and distorted seed. ×15. V.43372.

Phellodendron costatum Chandler p. 92

24. Seed, side; (*m*) micropyle; (*h*) hilar scar; (*r*) point where raphe enters testa. ×15. V.43373.

Fig.

25. Same, ventral, showing strap-shaped hilar scar, micropyle (*m*) and point of entry of raphe fibres (*r*) at opposite ends of it. ×6·5.
26. Holotype. Seed, side. ×15. V.20062.
27. Another, side; (*ch*) position of chalaza. ×6·5. V.42138.
28. Another, ventral. Lettering as in Fig. 25. ×6·5. V.42139.

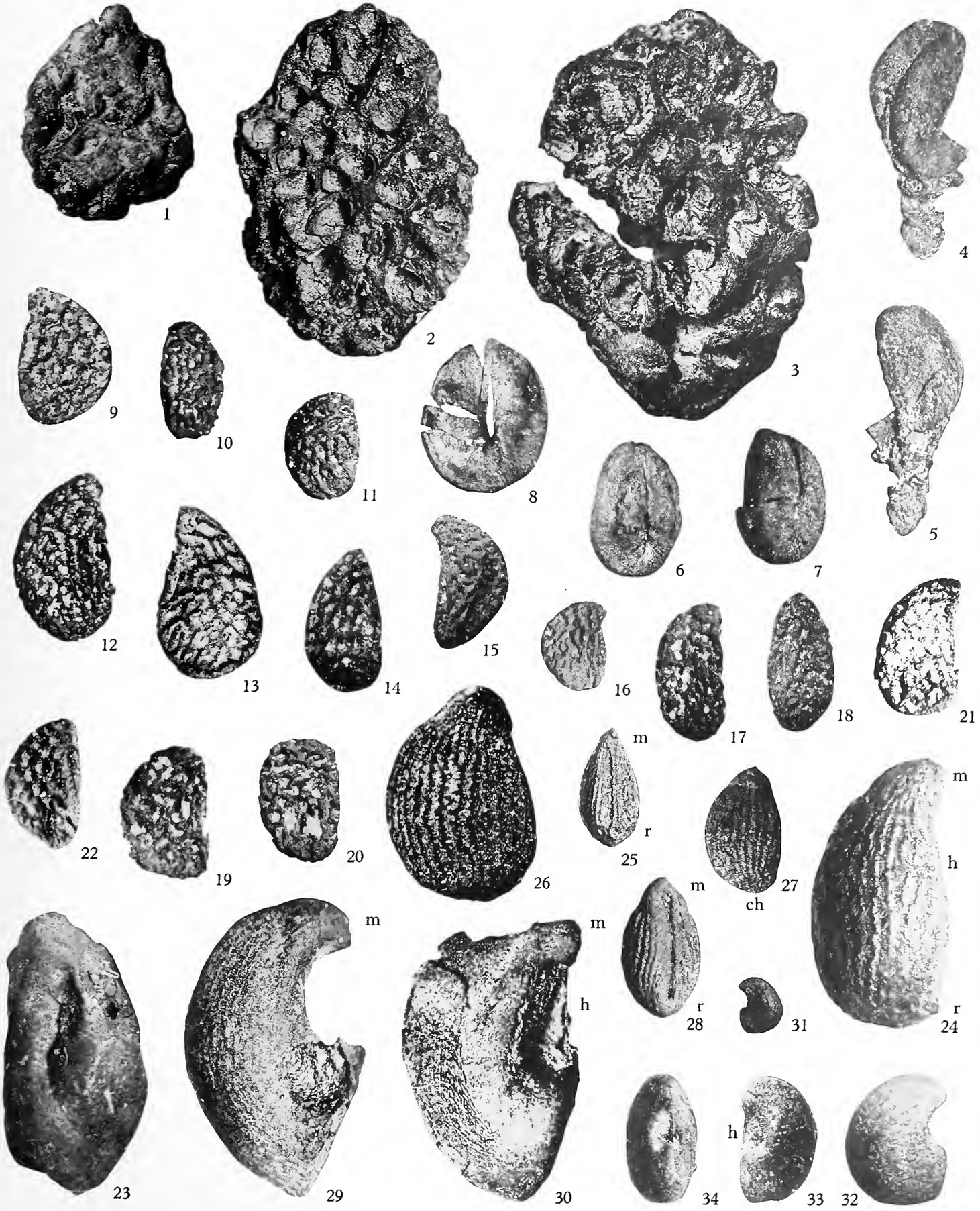
Toddaliospermum ornatum n. gen. & sp. p. 92

29. Holotype. Seed, side, showing deeply excavated ventral margin and fine surface ridges parallel with dorsal margin, also pitting. Excavation enlarged by breaking of margin along hilar scar; (*m*) micropyle. ×15. V.43395.
30. Another seed crushed. Shows perfect excavated short triangular hilar scar (*h*) and micropylar end (*m*). Outer coat of testa preserved in this specimen but not in that in Fig. 29. ×15. V.43396.

Toddaliospermum excavatum n. sp. p. 93

31. Holotype. Seed, side, showing deeply excavated ventral margin (left) and obscure ridging of surface parallel with dorsal margin. ×6·5. V.43397.
32. Same, opposite side. ×15.
33. Same, ventrilateral aspect, to show character of sunken triangular hilar scar (*h*). ×15.
34. Same, ventral. ×15.

Figs. 1–3, 30 Lignite above Boscombe Sands, Southbourne. Figs. 4–8, 11, 12, 23–25 Sandbanks; Figs. 10, 16, 17, 19, 20 Branksome Dene; all Bournemouth Freshwater Beds. Figs. 9, 13–15, 18, 26–28 Lower Headon, Hordle. Figs. 21, 22, 29, 31–34 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.



PROTOALTINGIA, HAMAMELIDACEAE GENUS (?), RUBUS, LEGUMINOSAE GENUS (?), PHELLODENDRON, TODDALIOSPERMUM

Explanation of Plate 15

Fig.

Rutaspermum exaratum (Heer) p. 95

1. Seed, side, subglobular. Hilar scar (*h*) occupying upper part of ventral margin. ×15. Geological Survey Coll.
2. Same, ventral, showing form of hilar scar. ×15.

Rutaspermum excavatum Chandler p. 93

3. Dorsilateral aspect of seed showing ridges and pittings of surface and demonstrating the difficulty of distinguishing this species from next when hilar scar not seen in profile. ×15. V.43375.

Rutaspermum rugosum n. sp. p. 94

4. Holotype. Seed, side, with perfect hilar scar (*h*). ×15. V.43379.
5. Large seed, hilum to left. ×15. V.43380.
6. Valve of seed showing ornamentation and hooked form. ×15. V.43381.
7. Another with longitudinal ridges widely spaced. ×15. V.43382.
8. Ventrilateral aspect of seed showing short triangular hilar scar (to left) having a median longitudinal furrow (surface cracked on right of scar). ×15. V.43383.
9. Seed with conspicuous ornamentation and short deep triangular hilar scar to right. This species or possibly *R. excavatum*. ×15. V.43386.
10. Seed so abraded that ridges appear rounded and surface much smoother than in unworn specimens. Hilum to right. Hilar opening at end of hook. ×15. V.43387.
11. Smaller seed, similarly abraded. Hilar scar to left. ×15. V.43388.
12. Inner surface of fragment of testa showing circular chalaza scar (*ch*). Raphe partly exposed in section on left at (*r*). ×15. V.43389.
13. Another fragment (external surface) showing lower end of hilar scar with opening into raphe canal at its base. ×15. V.43390.
14. Much cracked decaying seed broken at micropylar end; side. Hilar scar to left. Seed cavity exposed above by break. ×15. V.43394.
15. Same, ventral, showing hilar scar. ×15.

Palaeobursera lakensis Chandler p. 96

16. Endocarp, dorsal. Valve becoming detached. Its lower limits are at (*l*,*l*). ×6·5. V.43398.
17. Same, ventral. Split in fossilization along median ventral angle above, angle now flattened. Ragged edges of valve project on each side above letters (*l*,*l*). (Surface with embedded grains of white sand.) ×15.
18. Narrower endocarp, ventral, showing median angle (distorted); (*p*) foramen for placenta. ×15. V.43402.
19. Another endocarp, dorsal, with valve removed exposing locule. Narrow obcordate chalaza scar seen on adhering testa at (*ch*). ×15. V.43403.
20. Larger endocarp, dorsal, with valve removed. Chalaza scar (*ch*) as in Fig. 19. ×15. V.43404.
21. Valve, exterior, from endocarp in Fig. 20. ×15.

Figs. 1, 2 Bovey Tracey Lignite, Devon. Figs. 3–8 Lignite above Boscombe Sands, Southbourne; Figs. 9–13 carbonaceous lenticle, base of Boscombe Sands, Southbourne. Figs. 14, 15 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 16, 17 Sandbanks and Figs. 18–21 Branksome Dene; all Bournemouth Freshwater Beds.

RUTASPERMUM, PALAEOBURSERA

Explanation of Plate 16

Fig.

Euphorbiotheca spp. p. 96

1. Fruit. Endocarp seen at (*e*) owing to removal of some of exocarp in fossilization. ×15·5. V.43406.
2. Same, opposite side. Break in fossilization shows a locule at (*l*). Over most of this surface exocarp missing. ×15·5.
3. One carpel of several-carpelled capsule still attached to leathery peduncle. Loculicidal dehiscence has occurred down the middle. ×15·5. Decayed.
4. Opposite side showing plane of septicidal dehiscence with characteristic oblique fissure. ×15·5.

?Rhus sp. p. 97

5. Skeletonized mesocarp still partially embedded in and held together by matrix. Sepals obscurely seen at (*s*). ×6·5. V.43063.

Spondiaecarpon operculatum Chandler p. 97

6. Endocarp showing wide prolongation of fruit wall between two inclined apical germination valves. ×6·5. V.43407.
7. Same, opposite side, with valve separated by only a narrow tongue of fruit wall. ×6·5.

Natsiatum eocenicum Chandler p. 98

8. Impression of endocarp showing characteristic reticulate surface surrounded by belt of fine radial striae due to contraction of original carbonaceous specimen. ×3. V.43408.

Stizocarya sp. p. 99

9. Endocarp, much broken. It shows blunt-ended prominences of surface. ×6·5. V.43409.

?Meliosma sheppeyensis Reid & Chandler p. 99

10. One valve of dorsiventrally compressed, distorted endocarp, exterior, seen from below. (*a*) aperture for placental plug. ×15. V.43410.
11. Other valve of same endocarp, interior. (*a*), funicular aperture leading into short canal to placenta. ×15.
12. Valve of another endocarp, external surface. ×6·5. V.43411.
13. Interior of other valve showing funicular aperture and canal at (*a*). ×15·5.

Frangula hordwellensis Chandler p. 100

14. Pyrene showing hilar excavation of projecting seed at base of figure. ×6·5. V.43412.
15. Same, opposite surface, with median suture. ×6·5.

Vitis spp. p. 101

16. Distorted seed, dorsal grooved apex, scarcely stipitate base and narrow oval chalaza. ×6·5. V.43413.
17. Same, looking onto one ventral facet. Ventral infold shows obscurely. Dorsal surface to right. ×6·5.
18. Seed, dorsal, showing furrowed apex, chalaza and long stipitate base. ×6·5. V.43414.

Fig.

19. Same, ventral, showing raphe ridge and short divergent infolds. ×6·5.
20. Seed, dorsal, much abraded; chalaza obscure. ×6·5. V.43415.
21. Same, ventral, showing raphe ridge; infolds obscure. ×6·5.
22. Seed, imperfect at base and slightly compressed and distorted. Dorsal surface showing chalaza and a few furrows diverging from it. ×6.5. V.43416.
23. Same, ventral surface. Ventral infolds are slightly convex to raphe ridge but are broken below. ×6·5.
24. Facet of ventral surface showing infold. ×6·5. V.43418.
25. Upper end of dorsal surface, chalaza not preserved. ×6·5. V.43419.
26. Detached chalaza scar. ×6·5. V.43417.
27. Ventral facet, broken below, showing infold. ×6·5. V.43420.

?Tilia sp. p. 103

28–32. Five pollen grains photographed and determined by J. B. Simpson. Figs. 29–31 polar view, Fig. 29 an unusual four-furrowed grain, the others three-furrowed. Figs. 28, 32 plan view. ×1000.

Grewia minima n. sp. p. 104

33. Holotype. External surface of an imperfect endocarp. ×15·5. V.43422.
34. Opposite side showing two of three locules; that on left is exposed because one valve has come away, that on right by fracture in fossilization. ×15·5.

Actinidia eocenica n. sp. p. 104

35. Holotype. Perfect seed and part of another closely adpressed to it and folded round it. ×15·5. V.43423.
36. Opposite side of above. Contiguous hilum and micropyle are preserved on adherent seed fragment. ×15·5.
37. Small but perfect seed (immature?). Hilum and micropyle at top of figure. ×15·5. V.43424.
38. Distorted crushed seed, split longitudinally but more or less complete. ×15·5. V.43426.
39. Chalazal end of large seed. ×15·5. V.43425.

Figs. 1–8, 10–13, 16–21, 28–32, 35–39 Bournemouth Freshwater Beds: Figs. 1–4, 10–13, 16–21, 28–32, 35–39 Sandbanks; Fig. 5 between Alum and Durley Chines, Bournemouth; Figs. 6, 7 Branksome Dene; Fig. 8 between Alum and Middle Chines, Bournemouth. Figs. 14, 15, Bournemouth Marine Beds, Leafy lenticle, cliff base, Southbourne. Figs. 9, 22, 23 Lignite above Boscombe Sands, Southbourne. Figs. 24–27, 33, 34 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.

EUPHORBIOTHECA, RHUS, SPONDIAECARPON, NATSIATUM, STIZOCARYA, MELIOSMA, FRANGULA, VITIS, TILIA, GREWIA, ACTINIDIA

Explanation of Plate 17

Fig.

Actinidia eocenica n. sp. p. 104

1. Fragment of seed showing internal surface with convexities corresponding with external pits. ×15·5. V.43427.
2. Small but perfect seed. Raphe marked by longitudinal fold, contiguous hilum and micropyle at top of figure. ×15·5. V.43429.
3. Same, opposite side. ×15·5.
4. Fragment of seed showing foveolate external surface broken at hilar end (above). ×15. V.43430.
5. Same, interior, showing convexities of internal surface, obscure in figure, which correspond with external foveolae. ×15.

Actinidia poolensis n. sp. p. 105

6. Holotype. Complete seed. Contiguous hilum and micropyle at top of figure. ×15. V.43431.

?Gordonia truncata Chandler p. 106

7. Holotype. Basal end of dehisced five-loculed fruit. It shows lower end of axis (*a*) and segments of capsule. Broad, truncate character of fruit base clearly shown. ×15·5. V.43432.
8. Same, opposite side. ×15·5.
9. Same, from above. It shows valves (numbered 1–5) of transversely broken capsule connected by thin septa, with axis (=columella). Locules lie between septa. Whole somewhat laterally crushed. ×15·5.

Cleyera? stigmosa (Ludwig) p. 108

10. Seed, inner face of one valve exposed by longitudinal splitting in plane of symmetry; (*m*) micropyle; (*h*) hilum. Shows curved seed cavity and long "condyle" of testa between limbs. Chalaza near base of shorter limb on inner curve. ×15. V.34248.

11–14. Four seeds, external surface, showing variable form and surface pitting. ×15. V.43433–35, V.43439.

15, 16. Seed fractured longitudinally but irregularly showing structure of testa and condyle between limbs of curved cavity. ×15. V.43436.

17. Valve of another seed, inner surface, showing testa and curved seed cavity. ×15. V.43437.

18–20. Three seeds showing variations of form and size. ×15. V.43440–42.

21. Seed, inner surface of one valve after longitudinal fracture showing curved seed cavity and limbs separated by "condyle" of testa. ×15. V.43443.

22–25. Four seeds. ×15. V.43446, V.43448, V.43450–51.

26, 27. Two crushed and abraded seeds. ×15. V.43454–55.

28. Large seed. ×15. V.43459.

Fig.

29, 30. Two seeds showing variation in size and form. ×15. V.43460–61.

31, 32. Large seed represented by two valves. Fig. 31 shows exterior of one, Fig. 32 interior of other. It also shows thickness of wall and columnar arrangement of its cells. ×15. V.43462.

33, 34. Specimen showing exterior and interior of a valve. ×12. Decayed.

35, 36. Seed (Fig. 35) with cast of seed cavity (Fig. 36) representing embryo. ×12. V.43465.

Cleyera? lentiformis n.sp. p. 109

37. Holotype. Seed showing outline and pitting of surface. ×15. V.43471.
38. Same, base, showing hilar aperture from which surface pitting diverges. Marginal splitting has begun on left. ×15.
39. Inner surface of one valve showing columnar arrangement of cells in thickness of wall; (*m*) micropylar limb. Basal hilar aperture (*h*) leading into raphe canal in thickness of condyle. Chalaza indicated by dark shadow (*ch*) at tip of left-hand limb. ×15.
40. Other valve of same seed, inner surface; (*m*) micropylar limb. ×15.

?Cleyera sp. p. 110

41. Much broken valve of seed, external surface. ×15. V.43472.
42. Same, inner surface, showing curved cavity and large condyle between limbs, micropyle at tip of right limb; (*h*) hilum; (*ch*) chalaza. ×15.
43. Broken valve of second seed, external surface. ×8·5. V.43473.
44. Same, internal surface. ×8·5.
45. Much compressed seed, broken at hilar end. ×15. V.43474.

Figs. 1–3, 6, 10–21 Bournemouth Freshwater Beds: Figs. 1, 10, 11, 12-17 Sandbanks; Figs. 2, 3, 6, 18–21 Branksome Dene. Figs. 4, 5, 7–9, 28–45 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 23–25 Bournemouth Marine Beds Fig. 23 Marine Sands just east of East Cliff lift, Bournemouth; Fig. 24 dark sands, cliff base, Southbourne; Fig. 25 Leafy lenticle, cliff base, Southbourne. Figs. 26, 27 Lignite above Boscombe Sands, Southbourne. Fig. 22 dark lignitic clays, Bracklesham Beds, Alum Bay, Isle of Wight.

ACTINIDIA, GORDONIA, CLEYERA (?)

Explanation of Plate 18

Fig.

Theaceae. Section Taonabeae. Genera? p. 111

1. Seed, broken at base, external surface. Near valve broken on right so that inner surface of second valve exposed partly in deep shadow. ×15·5. V.43475.
2. Second valve of same seed, internal surface after removal of broken near valve. It shows the long narrow condyle between two limbs and canal which lies in middle of it. ×15·5.
3. Inner surface of broken valve. Condyle preserved and part of one limb of seed cavity. ×15·5.
4. Tegmen released from seed of another genus (p. 112) by decay of testa in fossilization; (*ch*) chalaza; (*m*) micropylar limb (slightly damaged). ×15. V.43476.
5. Opposite side of same before micropylar limb (folded on itself) had been straightened out as in Fig. 4. ×15.

Eurya mudensis n.sp. p. 107

6. Holotype. Seed, broad surface showing thickening of testa in hilar raphe region (*h*). ×15. V.43477.
7. Another, more subcircular in form. ×15. V.43478.
8. Seed somewhat smoothed by abrasion; (*h*) hilum. ×15. V.43481.
9. Another. ×15. V.43482.
10. Broken seed, showing part of longitudinal section. Internal projection of testa near hilum seen and small raphe cavity delimited by it. Also shows broken reniform seed cavity. ×15. V.43479.
11. Another seed showing internal structure, inner surface much corroded and sand encrusted. ×15. V.43480.

Oncoba rugosa Chandler p. 112

12. Fragment of seed fractured longitudinally in fossilization through chalaza scar at upper end of figure. ×8·5. V.43495

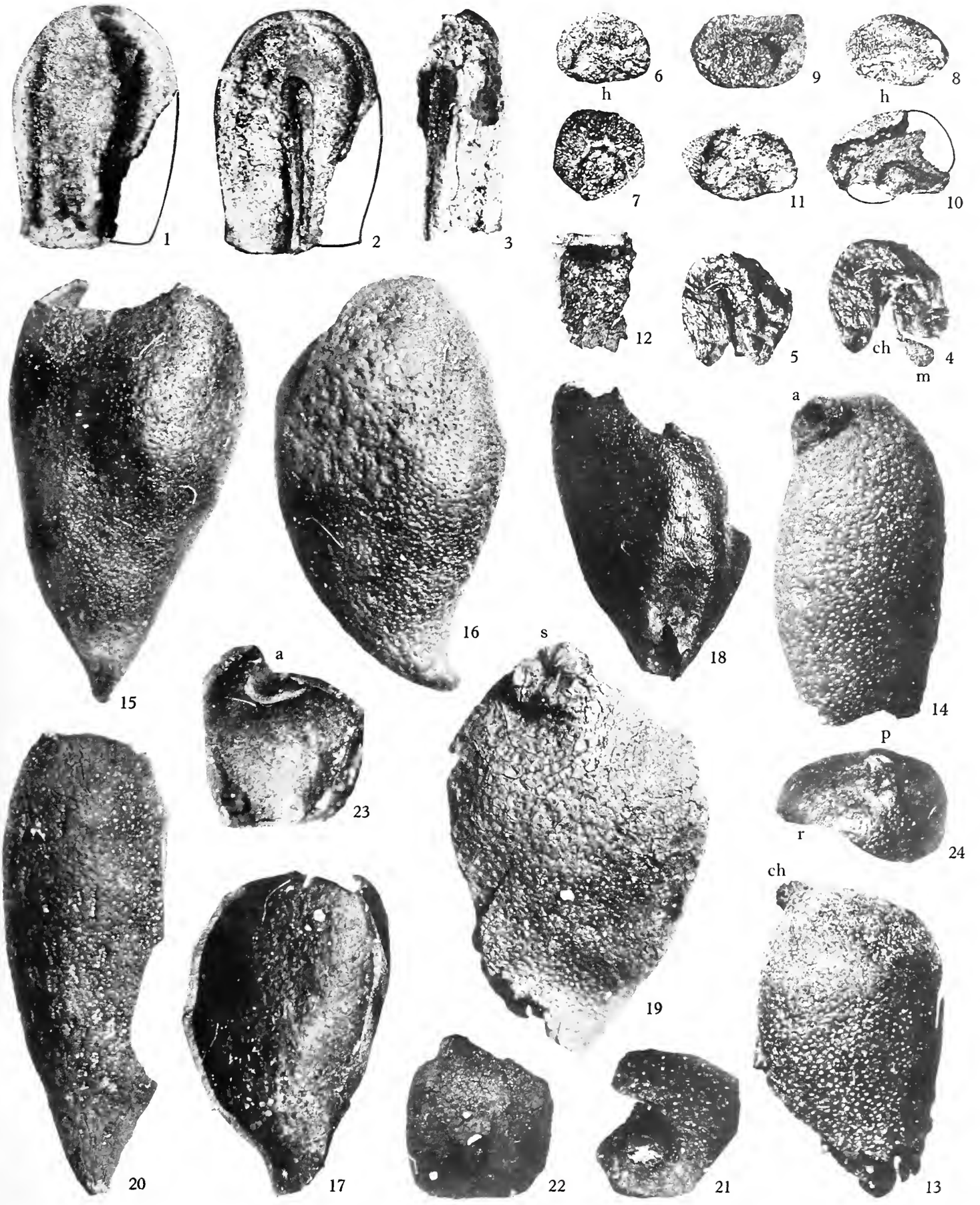
Thymelaeaspermum bournense n.sp. p. 113

13. Holotype. Part of seed showing projection (*ch*) formed by chalaza and character of coriaceous tegmen with its large external pits. ×15. V.42238.

Fig.

14. Similar specimen; aperture to chalaza exposed at (*a*). ×15. V.42239.
15. Seed showing micropylar end, chalaza end imperfect. ×15. V.42240.
16. Another seed, broken at chalaza end, but showing curved micropylar end. ×15. V.42241.
17. Seed, imperfect at both ends, especially at chalaza, in longitudinal section. It shows crustaceous tegmen with curved columnar cells. ×15. V.42242.
18. Imperfect seed; micropylar end only slightly broken. Longitudinal sinuous lines on tegmen are impressions of abraded testa cells. ×15. Decayed.
19. Crushed seed showing tegmen in section at (*s*). ×15. V.42243.
20. Elongate seed, broken on right and at chalaza end showing grouping and alignment of large pits on surface of tegmen. ×15. V.42244.
21. Chalaza end of seed showing aperture full of white sand where raphe enters knob-like chalazal projection. ×15. Decayed.
22. Similar fragment. Aperture for raphe clear of matrix. ×15. Decayed.
23. Chalazal end of seed seen in longitudinal section. Shows chalazal projection pierced by raphe at (*a*). Internal scar of chalaza visible below this aperture. ×15. V.42245.
24. Chalaza end of seed with prominence (*p*) over chalaza. On specimen remains of lateral raphe can be seen at (*r*). ×15. V.42248.

Figs. 1–12 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 13–23 Lignite above Boscombe Sands, Southbourne. Fig. 24 Leafy lenticle, cliff base, Southbourne, Bournemouth Marine Beds.



THEACEAE GENERA (?), EURYA, ONCOBA, THYMELAEASPERMUM

Explanation of Plate 19

Fig.

Thymelaeaspermum bournense n.sp. p. 113

1. Micropylar end of seed with well preserved tegmen showing large number of superficial depressions grouped in clusters or lines. Fractured longitudinally when found. ×15. V.42249.
2. Same, inner surface. Section of tegmen shows curved columnar cells. ×15.
3. Part of seed, chalazal end, showing hood-like chalazal prominence (*ch*). Large scattered depressions shown on surface of tegmen. ×15. V.42250.
4. Similar but smaller fragment. ×15. V.42251.
5. Another fragment showing aperture into chalaza. ×15. Decayed.

Daphne bournensis n.sp. p. 116

6. Seed, side, chalazal end at top of figure. ×15. V.36482.
7. Another seed, micropylar end at (*m*) (slightly incomplete). ×15. V.36481.
8. Holotype. Perfect seed. (*m*) micropyle; (*ch*) chalaza. ×15. V.36483.

Microdiptera major n.sp. p. 118

9. Holotype. Stipitate seed, ventral, showing raphe. ×15. V.42255.
10. Same, dorsal, showing pitted operculum and swirling fibrous structure of surface. ×15.

11, 12. Two seeds, dorsal. Operculum beginning to gape at base in Fig. 11. ×15. V.42256–57.

13. Seed, ventral, showing thickening associated with raphe. Aperture near apex an accidental break in chalazal area. ×15. V.42258.
14. Seed, dorsal, with operculum extruded. ×15. V.42259.
15. Another similar seed, dorsal, showing stipitate form. ×15. V.42260.
16. Fragment of fruit with numerous seeds in locule in position of growth (cf. Text-fig. 21). ×15. V.42262.
17. Stipitate seed, dorsal, with pitted operculum. ×15. V.42263.
18. Another, less stipitate, dorsal. ×15. V.42264.
19. Same, ventral, showing raphe flanked by grooves filled with white sand. ×15.

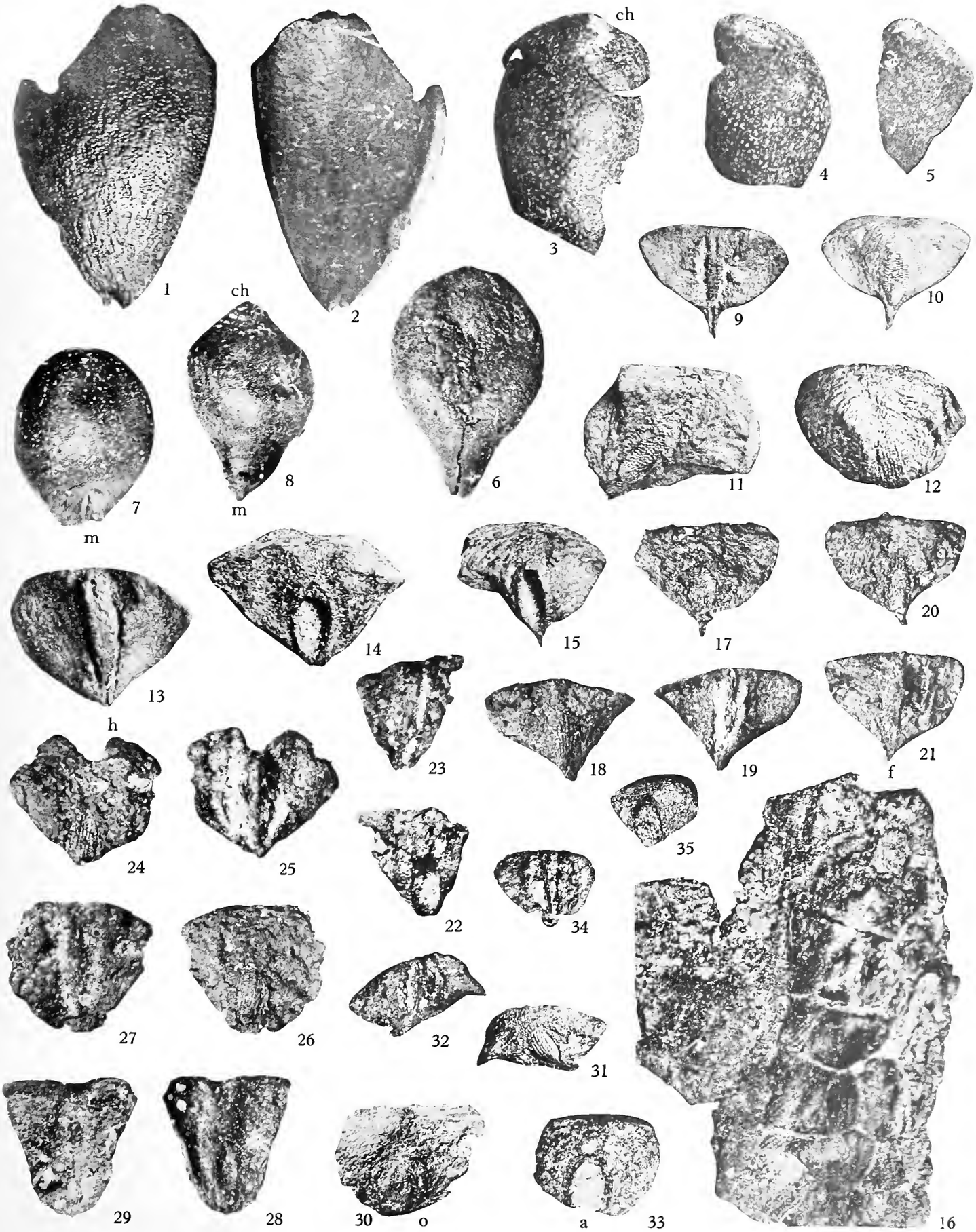
Fig.

20. Stipitate seed, dorsal, with pitted operculum. ×15. V.42265.
21. Same, ventral, with raphe arising out of funicle (*f*) which forms part of stipitation. ×15.
22. Small triangular seed, dorsal. Operculum shed exposing seed cavity. ×15. V.42266.
23. Same, ventral, with raphe. ×15.
24. Seed, dorsal, with pitted operculum and emarginate apex. ×15. V.42267.
25. Same, ventral, with raphe. ×15.
26. Subcircular seed, dorsal. ×15. V.42268.
27. Same, ventral. ×15.
28. Narrow triangular seed, dorsal, operculum beginning to gape. ×15. V.42269.
29. Same, ventral. Raphe obscure. ×15.

Microdiptera parva Chandler p. 119

30. Suboval seed, slightly imperfect at margin on right. Dorsal surface with operculum (*o*) and striations of inner coat swerving around it. ×15. V.42272.
31. Seed, dorsal, showing regularly pitted oval operculum. Note irregular outline, pointed wings and marked hilar stipitation. ×15. V.42273.
32. Same, ventral, showing median raphe flanked by deep concavities on wings. ×15.
33. Seed, dorsal, germination valve lost, its aperture (*a*) now filled with sand. ×15. V.42274.
34. Small seed, ventral. ×15. V.42275.
35. Another seed, dorsal. ×15. V.42276.

Figs. 9–29 Bournemouth Freshwater Beds: Figs. 9-15 Sandbanks; Figs. 16–29 Branksome Dene. Figs. 1, 2 Leafy lenticle, cliff base, Southbourne, Bournemouth Marine Beds. Figs. 3–5, 30–35 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 6–8 Lignite above Boscombe Sands, Southbourne.



THYMELAEASPERMUM, DAPHNE, MICRODIPTERA

Explanation of Plate 20

Fig.

Diclidocarya menzelii E. M. Reid p. 119

1. Seed, dorsal, showing elliptical operculum splitting from seed body. ×15. V.42300.
2. Larger seed with pitted operculum and transverse or oblique striations on the surfaces surrounding it. ×15. V.42301.
3. Another, ventral, showing median longitudinal raphe. ×15. V.42302.
4. Another narrow seed, grooves separate raphe from surrounding testa. ×15. V.42303.

Palaeolythrum bournense Chandler p. 120

5. Holotype. Seed, dorsal, showing ridges of testa and broad marginal flange. ×15·5. V.36487.
6. Same, ventral. Ridges converge to apical chalaza. Raphe median longitudinal. ×15·5.
7. Another. ×15·5. V.42285.
8. Same, ventral. ×15·5.
9. Much abraded seed showing obovate tegmen partly surrounded by decayed thin rimmed and longitudinally ridged testa. ×15. Decayed.
10. Another, tegmen. Testa represented by longitudinal fibres and ridges. Marginal flange not preserved. ×15. V.42286.

11, 12. Two much abraded seeds, tegmen. Testa represented only by a few longitudinal ridges; marginal flange worn away. ×15. V.42277–78.

13–16. Four seeds, tegmen only. In Fig. 16 innermost layers of abraded testa preserved. Chalaza scar (*ch*). Micropyle at base. ×15. V.42279–82.

17. Seed, tegmen. (*ch*) chalaza. ×15. V.42289.
18. Seed, much abraded with shining translucent tegmen exposed. ×15. V.42290.
19. Seed with adherent fragment of testa on left almost detached. ×15. Decayed.
20. Another with part of longitudinally ridged testa still adhering, marginal flanges gone. ×15. V.42292.
21. Seed with part of inner layer of outer coat preserved; (*ch*) chalaza; (*m*) micropyle. ×28. V.42291.

Palaeolythrum gailense n.sp. p. 122

22. Seed, testa abraded. ×15. Decayed.
23. Holotype. Seed with remains of pitted testa especially at one end. In places shining transversely striate tegmen exposed. ×15. V.42293.
24. Abraded seed, tegmen largely exposed showing asymmetrically placed chalaza (*ch*). ×15. V.42295.
25. Another with part of testa preserved. ×15. V.42294.

26–29. Four seeds, various stages of abrasion. ×15. V.42296–99.

Eomastixia rugosa (Zenker) p. 123

30. Much abraded endocarp. ×2·7. V.40783.

Mastixia? glandulosa Chandler p. 124

31. Typical but much crushed endocarp. ×6·5. V.42315.
32. Another, imperfect on right. Outer layers have cracked away exposing resin cavities in thickness of wall over part of surface. ×6·5. V.42316.

Fig.

33. Small endocarp. Outer layers again bursting away so that ducts full of resin are exposed. ×6·5. V.42317.
34. Endocarp. Outer layers have chipped away, on drying, exposing resin cavities. ×6·5. V.42319.
35. More or less perfect endocarp beginning to burst owing to expansion of resin (on drying) contained within thickness of wall. ×6·5. V.43011.
36. One end of endocarp showing external furrow (*f*) corresponding to internal infold. Bursting of wall on left is again due to swelling of resin in wall cavities. ×6·5. Decayed.
37. Decaying fragment of endocarp, inner surface, showing convexities produced by swelling resin in wall. Rounded masses of glistening resin seen on left where wall is in section. ×6·5. V.43018.

38, 39. Two smooth fragments of resin out of wall cavities of an endocarp. ×15. V.43019.

Dunstania glandulosa (Chandler) p. 125

40. Broken endocarp identified by secreting cavities, visible in actual specimen. ×3. V.43021.
41. Fruit with exocarp preserved. ×6·5. V.43025.
42. Abraded and somewhat compressed endocarp. Secreting cavities, scarcely visible in figure, are exposed in thickness of wall. ×6·5. V.43026.
43. Endocarp with locule cast protruding from one locule (*l*). Fragment of valve still adheres to upper end of locule cast. ×6·5. V.43027.
44. Same, turned to show another locule, valve and locule cast missing. Secreting cavities obscurely seen in abraded walls. ×6·5.
45. Much flattened endocarp, flattening in part original but in great measure due to compression in fossilization. (*a*) apical cavity. ×2·7. V.43022.
46. Transverse section of similar specimen, broken on right. Two compressed abortive locules visible lying horizontally in figure. Crushed ovoid secreting cavities are clear in specimen. ×15. V.43023.

Clethra hantonensis n.sp. p. 125

47. Holotype. Seed, dorsal; (*h*) hilum. ×15. V.43028.
48. Same, ventral. ×15.

Figs. 1–4 Brown Coal, Kauscha near Senftenberg, Germany. Figs. 5–17, 30, 40–42, 45, 46 Bournemouth Freshwater Beds: Figs. 5–10,41 Branksome Dene; Figs. 11–16, 40, 45, 46 Sandbanks, Figs. 11–16 fine laminated silt below Simpson's Folly; Figs. 30, 42 between Durley and Middle Chines, Bournemouth; Fig. 17 between Alum and Middle Chines, Bournemouth. Figs. 18, 31–33 Bournemouth Marine Beds: Fig. 18 dark sands, cliff base, Southbourne; Figs. 31–33 Leafy lenticle, cliff base, Southbourne. Figs. 19–21, 36–39, 43, 44, 47, 48 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 34, 35 Lignite above Boscombe Sands, Southbourne. Figs. 22–29 Lignitic Clays, Pont-de-Gail (Cantal), France.

DICLIDOCARYA, PALAEOLYTHRUM, EOMASTIXIA, MASTIXIA, DUNSTANIA, CLETHRA

Explanation of Plate 21

Fig.

Ericaceae. Section Andromedeae. Genus? sp.2? p. 126

1. Oblate spheroidal fruit seated on a large receptacle or placenta (*p*). ×15. V.43029.

Epacridicarpum headonense Chandler p. 126

2. Fruit, base. ×15. Decayed.
3. Another showing beginnings of loculicidal dehiscence. ×15. V.36486.

4, 5. Two detached loculicidal valves of a fruit, interior, showing septum (*s*) and locules (*l*). ×15. Decayed.

Epacridicarpum mudense Chandler p. 127

6. Fruit, apex, showing flat-topped style or axis. Loculicidal dehiscence has begun. ×15. V.43033.
7. Holotype. Fruit showing rugose surface. Tilted to expose part of the side. ×15. V.36486.
8. Fruit fractured longitudinally along loculicidal planes of dehiscence. It shows axis, placentas and two locules. ×15. V.43032.

Epacridaceae. Genus? p. 128

9. Imperfect fruit showing stalk, style and two dehiscing carpels, exterior. ×15. V.43035.

?Leucopogon sp. p. 129

10. Fruit with accrescent calyx and persistent bract; (*st*) style. Base truncate. ×15. V.43036.
11. Same, opposite surface. ×15.

Symplocos headonensis Chandler p. 129

12. Endocarp, worn and broken. External wall missing from locules, *l*2, *l*3. Locule *l*1, shows its apical aperture still intact. Septa exposed at (*sp*); seeds in locules 2 and 3. ×6·5. V.43037.

?Symplocos headonensis Chandler p. 130

13. Part of an originally four-loculed endocarp, exterior. ×6·5. V.43038.
14. Same fragment, inner surface showing two locules. Specimen has split longitudinally. ×6·5.

Symplocos sp. p. 130

15. Three-loculed endocarp, side. Aperture of one locule seen at top of figure. ×6·5. V.43507.
16. Larger endocarp, broken below. ×6·5. V.43508.

Symplocaceae? (or Cornaceae?). Genus? p. 131

17. Perianth disc or plug from inferior fruit, outer face showing style base and radially arranged cells. ×15. V.43039.
18. Same, inner face showing central circular scar and marginal area of equiaxial cells. ×15.

?Olea headonensis Chandler p. 131

19. Exterior of sand-pitted endocarp. ×6·5. V.43041.
20. Same, fractured longitudinally in plane of symmetry, interior, showing two locules and septum between them. ×6·5.

Fig.

Boraginaceae. Section Ehretioideae? Genus? p. 132

21. Two-lobed pyrene, inner surface. ×15. V.43042.
22. Same, outer surface. ×15.

Sambucus mudensis n.sp. p. 133

23. Holotype. Seed, dorsal surface, very slightly imperfect at hilum and micropyle (base of figure). ×15. V.43046.
24. Another broken at hilar end. ×15. V.43047.
25. Another similarly broken. ×15. V.43048.
26. Seed broken at chalaza end and on one side. Possibly a different species but too imperfect for diagnosis. ×15. V.43049.

Cucurbitospermum mudense n.sp. p. 134

27. Holotype. Valve of seed, external surface; (*h*) micropyle and hilum. ×8·5. V.43051.
28. Same, inner surface; (*ch*) chalazal end. ×8·5.

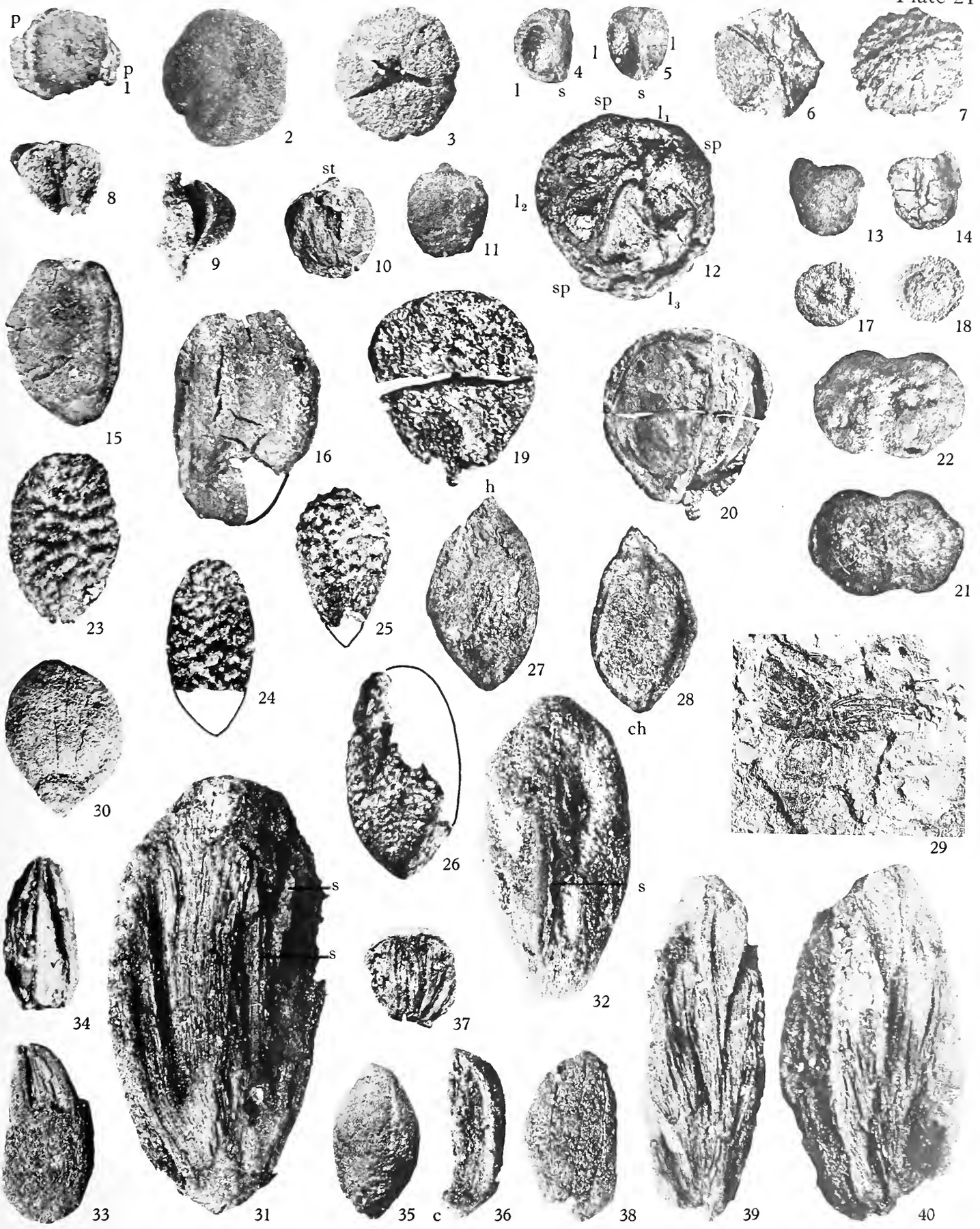
?Abelia sp. p. 133

29. Impression of three-winged fruit with triangular apical disc. Wings all imperfect distally. ×2·8. V.43050.

Wessexia fibrosa (Chandler) p. 135

30. Holotype. Fruit showing basal calyx and longitudinal splitting. ×6·5. V.20108.
31. Fruit fractured longitudinally showing fibre masses inside which fill carpels. Embedded seeds (*s*, *s*). ×15. V.42218.
32. Fruit with pericarp abraded so that parts of seeds (*s*) embedded in fibres, are exposed. ×15. V.42219.
33. Part of fruit, external surface. Pericarp removed in upper part exposing fibres which enclose cavities for seeds. ×6·5. V.42220.
34. Abraded fruit, interior, showing large cavity for seed in fibre mass. ×6·5. V.42221.
35. Fruit, exterior, showing groove which marks one longitudinal plane of separation into segments. ×6·5. V.20109*b*.
36. Part of fruit broken longitudinally showing basal calyx (*c*) and inner surface of a carpel with its mass of fibres. ×6·5. V.20109*c*.
37. Small fruit, with calyx gone, fractured longitudinally, showing inner surface filled with fibres. Cavities for seeds are seen in fibre masses. ×6·5. V.20109*a*.
38. Four-carpelled fruit, exterior, incomplete at base. Longitudinal segments can be seen. ×6·5. V.43525.
39. Valve of same fruit (carpel or segment), inner surface, showing fibre masses. ×15.
40. Same fruit, interior after removal of two valves. ×15.

Fig. 1 Leafy lenticle, cliff base, Southbourne, Bournemouth Marine Beds. Figs. 2–11, 17, 18, 21–28 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 12, 19, 20, 29, 38–40 Bournemouth Freshwater Beds: Figs. 12, 19, 20, 38–40 Sandbanks; Fig. 29 between Alum and Durley Chines, Bournemouth. Figs. 13-16 Lignite above Boscombe Sands, Southbourne. Figs. 30–37 Lower Headon, Hordle.



ERICACEAE GENUS (?), EPACRIDICARPUM, EPACRIDACEAE GENUS (?), LEUCOPOGON, SYMPLOCOS, SYMPLOCACEAE GENUS (?), OLEA, BORAGINACEAE GENUS (?), SAMBUCUS, CUCURBITOSPERMUM, ABELIA, WESSEXIA

Explanation of Plate 22

Fig.

Wessexia fibrosa (Chandler) p. 135

1. Fruit (imperfect), external surface, much abraded. ×15. V.43526.
2. Same, inner side, showing fibres (endocarp and septa) in which seeds are embedded. ×15.

Wessexia bournensis n.sp. p. 136

3. Holotype. Five-carpelled fruit, tilted to show apex. Loculicidal splitting can be seen at (*l*) but external surface much broken and imperfect. ×6·5. V.43527.
4. Same, broken to show interior with thick exocarp (*e*) and fibrous endocarp (*en*). Numerous seeds, sunk in pockets, are clear in specimen but difficult to distinguish in figure. ×6·5.

Carpolithus apocyniformis Chandler p. 137

5, 6. Outer (fig. 5) and inner (fig. 6) surfaces of a valve. ×6·5. V.43529.

7–14. Four other valves. Figs. 7, 9, 11, 14 outer, others inner surface. ×6·5. Figs. 7, 8 V.43531. Figs. 13, 14 V.43530. Others decayed.

15. Inner surface of small valve. ×6·5. Decayed.

Carpolithus ornatus n.sp. p. 137

16. Holotype. Tubercled seed somewhat compressed. ×15. V.43534.
17. Opposite side of same. ×15.

Carpolithus echinatus n.sp. p. 138

18. Holotype. Spiny seed. ×15. V.43536.
19. Another with somewhat shorter thicker tubercles. ×15. V.43537.
20. More stoutly tubercled form. ×15. V.43538.
21. Distorted seed encrusted with matrix, ventral side. It shows hilar scar near top of figure. ×15. V.43539.
22. Imperfect finely tubercled seed. ×15. V.43540.

Carpolithus spinossissimus n.sp. p. 138

23. Holotype. Spiny seed, broken longitudinally, showing inner surface. Internal convexities, which coincide with pits between the tubercles externally, can be seen. ×15. V.43541.
24. Other half of same seed, interior. ×15.
25. Seed, micropylar (or hilar) plug at (*p*). ×15. V.43542.

26–30. Five seeds. That in Fig. 29 slightly imperfect. ×15. V.43543–45, V.43547. Fig. 29 decayed.

31–35. Five seeds showing variation of form and size. ×15. All except Fig. 34 (V.43548) decayed.

Fig.

Carpolithus arnensis Chandler p. 139

36. Exterior of half a large woody fruit with an attachment at this end from which fibres diverge. Contraction on drying has caused fruit to split more or less along the radii. Originally specimen (as preserved) hemispherical. ×2·5. V.43533.
37. Same, interior. Rim of a conspicuous large basal scar seen at (*r*). ×2·5.

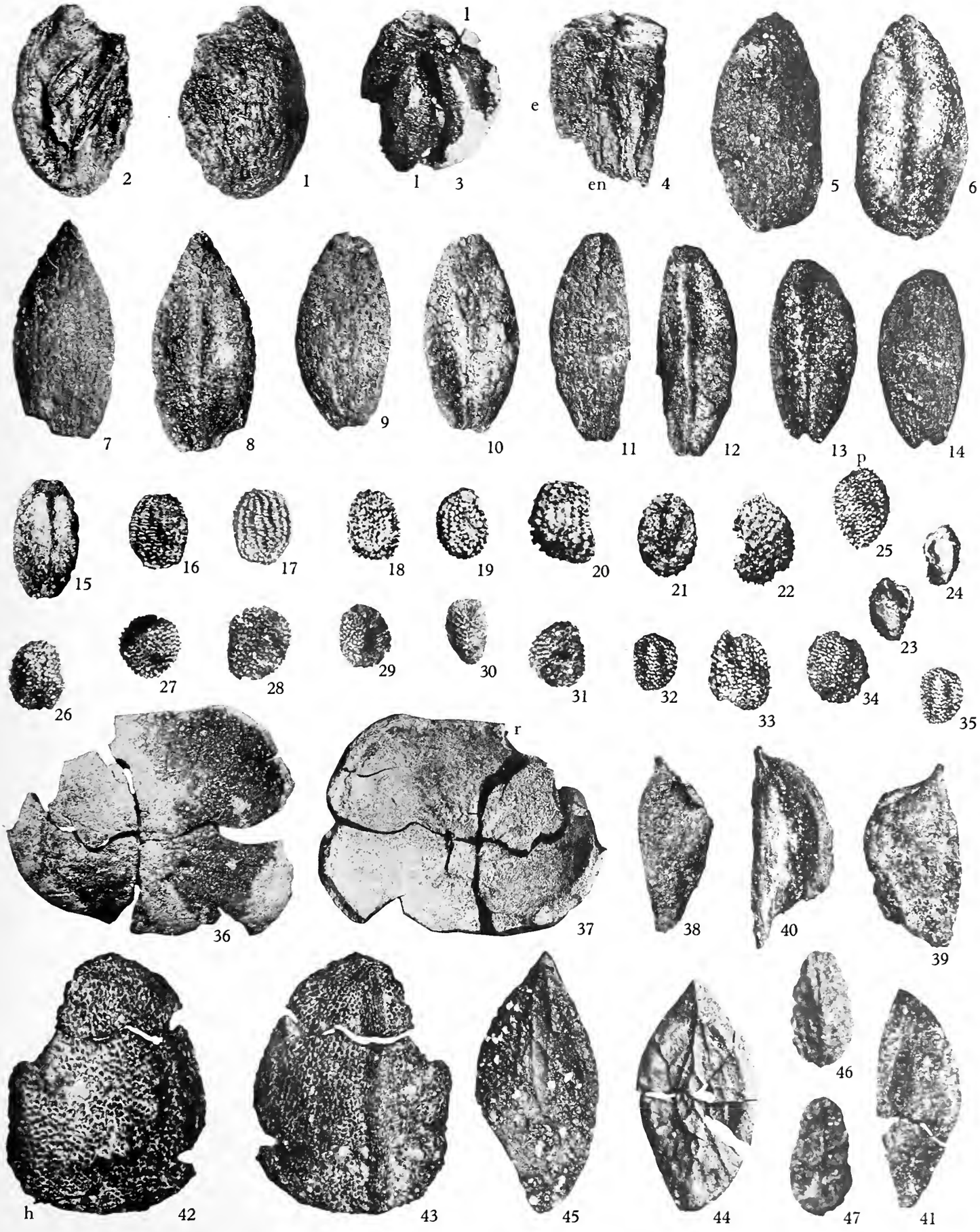
Carpolithus mudense n.sp. p. 140

38. Holotype. A perfect carpel. ×15·5. V.43549.
39. Another carpel with style preserved, slightly imperfect at base. ×15·5. Decayed.
40. Half a carpel broken at base but showing patent style and locule surface. ×15·5. V.43550.
41. Carpel, fractured transversely. ×15·5. V.43551.

Carpolithus spp. p. 141

42. Crushed seed, slightly imperfect on left above. It shows tubercled surface. (*h*) hilum? ×15. V.43588.
43. Same, opposite side, a longitudinal rounded ridge marks the raphe. Point where it emerges from seed near apex of figure marks chalaza. ×15.
44. Pod or bivalved fruit, surface well preserved but pod cracked and badly broken. ×6·5. V.43559.
45. Second specimen, much sand-pitted. White patches are adherent sand grains. ×6·5. V.43558.
46. Seed, convex surface. ×15. V.43557.
47. Same, flat surface. Both sides show rounded depressions and a median ridge. ×15.

Figs. 1, 2, 16–22, 38–41 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 3, 4, 23–35, 44–47 Bournemouth Freshwater Beds: Figs. 3, 4 between Alum and Durley Chines, Bournemouth; Figs. 23–30, 44–47 Sandbanks; Figs. 31–35 Branksome Dene. Figs. 5–15, 42, 43 Lignite above Boscombe Sands, Southbourne. Figs. 36, 37 Bournemouth Marine Beds, coarse sands, east end of beach cliff base, Southbourne.



WESSEXIA, CARPOLITHUS

Explanation of Plate 23

Fig.

Carpolithus spp. p. 142

1. Fruit with persistent calyx fractured longitudinally to show axis and coarse oblique cells of a septum. ×15. V.43565.
2. Subglobular seed with network of sharp ridges. ×15. Decayed.
3. Another incomplete specimen with finer network of ridges. ×15. V.43591.
4. Small subglobular seed, dorsal, showing network of ridges all over surface. ×15. V.43592.
5. Same, ventral, with median depression and ridges nearer margin. ×15.
6. Exterior of valve of fruit with attachment or superior perianth scar at one end, broken at other. ×15. V.43589.
7. Same, interior, showing cavity. ×15.
8. Similar but narrower specimen showing clearly longitudinally aligned surface cells. ×15. V.43590.
9. Same, interior, with cells of locule wall preserved. ×15.

Bract?

10. Trifid scale or bract. ×15·5. V.43585. p. 155

Carpolithus spp. p. 143

11. Seed, surface showing median longitudinal rounded angle and basal truncation. ×15. V.43593.
12. Another, opposite flat surface. Basal aperture seen at truncate end. ×15. Decayed.
13. Obcordate fruit with attachment scar at emarginate end. ×15. V.43598.
14. Same, opposite side, attachment scar (*s*). ×15.
15. Flattened fruit with marginal wing or flange; (*a*) attachment. ×15. V.43600.
16. Seed. ×15. V.43556.
17. Another with hilum at (*h*) on obliquely truncate basal margin. Both seeds show surface rugosities. ×15. V.43555.
18. Valve of tubercled endocarp or seed (accidentally split). ×15. V.43564.
19. One carpel of pod or capsule with broad raised branching fibres. ×6·5. V.43560.
20. Another specimen with apex broken. ×6·5. V.43561.
21. Third with apex and attenuated base both broken. ×6·5. V.43562.
22. Carpel of fruit with gynobasic style lying in matrix. ×2·5. V.43575.

Fig.

Scale? p. 157

23. Thick scale-like body with broken tip, short thick stalk and rounded lateral lobes. ×2·5. V.43586.
24. Same, opposite surface. ×2·5.

Carpolithus spp. p. 147

25–35. Small seeds or sporocarps? ×15. Fig. 25 V.43605, Fig. 33 V.43607, rest decayed.

36. Small oval fruit or sporocarp. ×20. V.43609.
37. Flanged or winged fruit. ×15. V.43587.
38. Same, opposite side. ×15.

Placenta? p. 157

39. Six-lobed bolster-shaped organism, solid in transverse section. Placenta? There is a median constriction across lobes. ×6·5. V.43610.

Dicotylophyllum pinnatifidum Reid & Chandler p. 135

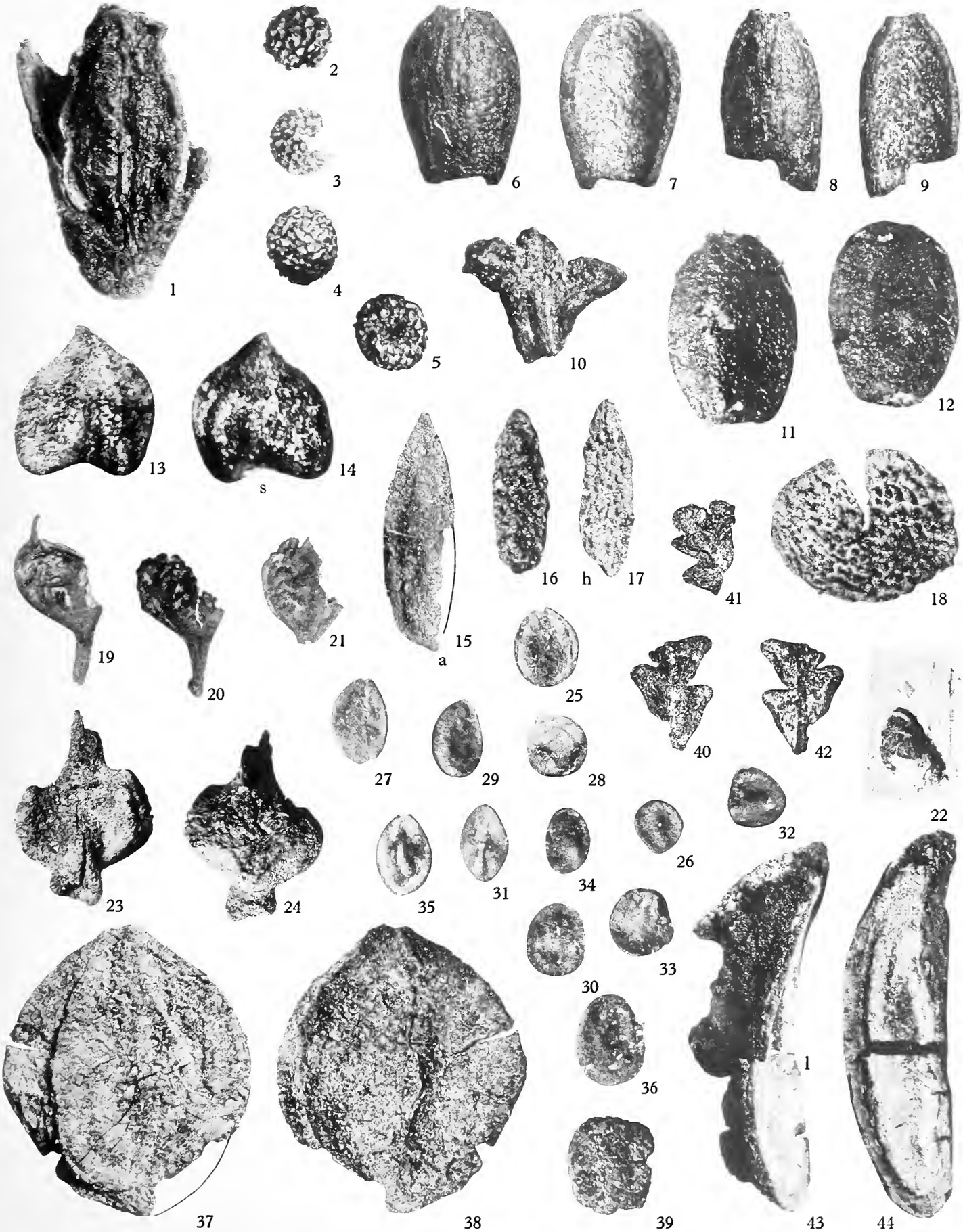
40, 41. Two fragments of pinnule, upper surface. ×6·5. Fig. 40 V.43603, Fig. 41 decayed.

42. Same as Fig. 40, lower surface. ×6·5.

Carpolithus sp. p. 147

43. Battered valve representing half a coccus which has split loculicidally; (*l*) locule. Outer surface much corroded and broken but shows coarse angular parenchyma. ×6·5. V.43584.
44. Same, tilted to show surface of locule. ×6·5.

Figs. 1, 16–22, 25–35 Bournemouth Freshwater Beds: Figs. 1, 16–21, 25–32, 34, 35 Sandbanks; Fig. 22 between Alum and Durley Chines, Bournemouth; Fig. 33 Branksome Dene. Figs. 2, 3, 6–9, 11–15, 36, 40–42 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford. Figs. 4, 5, 39 Lignite above Boscombe Sands, Southbourne. Figs. 10, 23, 24, 37, 38, 43, 44 Bournemouth Marine Beds: Figs. 10, 23, 24, 43, 44 Honeycomb Chine, Boscombe; Figs. 37, 38 Leafy lenticle, cliff base, Southbourne.



CARPOLITHUS, BRACT (?), SCALE (?), PLACENTA (?), DICOTYLOPHYLLUM

Explanation of Plate 24

Fig.

Carpolithus sp. p. 148

1. Impression of winged fruit or seed. ×2·7. V.16580.

Cupule? p. 155

2. External surface of half a cupule which has been broken longitudinally. It shows a marked scar at the base where it springs from the stem. There are indications of three perianth segments above. ×3. V.43630.
3. Same, inner surface. ×6·5.

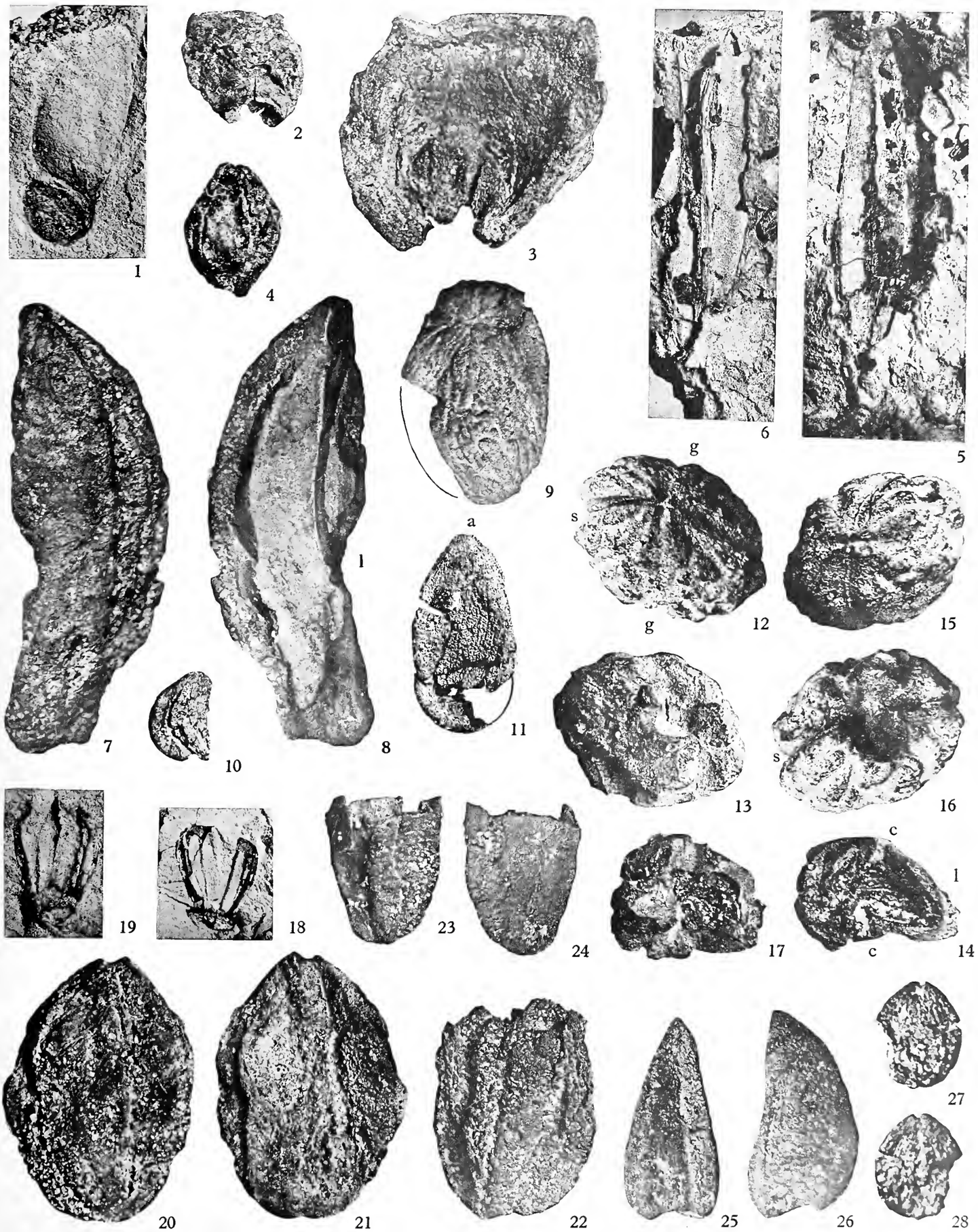
Carpolithus spp. p. 148

4. Five-partite capsule. ×15. Decayed.
5. Internal cast of five-loculed fruit with adherent remains of carbonaceous fruit wall. Septa median and left in dark carbonaceous matter. Specimen lies in matrix. ×1·7. V.32108.
6. Second less perfect specimen. ×2. V.43581.
7. Loculicidal valve incomplete at end towards base of figure outer surface longitudinally ridged on right. ×6·5. V.43579.
8. Opposite side of valve showing locules (*l*); broken along ventral margin. ×6·5.
9. Exterior of rugose fruit, distorted so that apex (or base?) shown. × 6·5. V.43566.
10. Seed?, perhaps showing separation of seed body (left) from thickened raphe (right). ×15. V.43602.
11. Rugose seed or fruit with rounded base and small aperture at (*a*). ×2·3. V.43577.
12. Endocarp, apex, showing splitting at (*s*) in one plane of symmetry. Other marked by a groove (*g*, *g*). ×9. V.43583.
13. Same, base. ×9.
14. Same in longitudinal section showing a central canal (*c*, *c*); fertile locule (*l*) and abortive locule on the opposite side of canal. ×9.
15. Another endocarp, apex. ×9. V.43582.
16. Same, base, plane of splitting at (*s*). ×9.
17. Same, longitudinal section. ×9.

Fig.

18. Loculicidal capsule seated on puckered and wrinkled receptacle with remains of peduncle. Apex of capsule truncate. ×1·7. V.43572.
19. Somewhat similar capsule with pointed apex. ×1·7. V.43573.
20. Crushed longitudinally flanged fruit. ×6·5. V.43567.
21. Same, opposite surface. ×6·5.
22. Fruit, imperfect above. Furrow marks junction of septum with external wall. It is flanked by two locules. Puckered surface clearly seen. ×6·5. V.43568.
23. Smaller specimen, lower half only. ×6·5. V.43569.
24. Same, opposite side. ×6·5.
25. Seed with deep oval depression at one end. ×15. V.43597.
26. Another. ×15. V.43596.
27. Crushed fruit with glistening crumpled surface. ×15. V.43601.
28. Same, opposite surface. ×15.

Figs. 1–9, 11–24 Bournemouth Freshwater Beds: Fig. 1 Canford Chine, Bournemouth; Figs. 2, 3, 6, 11–19 between Alum and Durley Chines, Bournemouth; Figs. 4, 9 Sandbanks; Fig. 5 between Branksome and Canford Chines, Bournemouth; Figs. 7, 8 between Durley and Middle Chines, Bournemouth; Figs. 20–24 Branksome Dene. Figs. 10, 25–28 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.



CARPOLITHUS, CUPULE (?)

Explanation of Plate 25

Fig.

Carpolithus spp. p. 153

1. Small carpel. ×15. V.43595.
2. Seed with large rimmed basal foramen and a lateral rounded ridge which suggests the raphe. ×15. V.43599.
3. Convex side of small seed with crumpled rugose surface. ×15. V.43570.

4, 5. Two five-angled fruits, buds or other organs. ×15. V.43631–32.

Unknown organ p. 157

6. Undetermined organ with superficial subcircular resinous secretions. ×15. V.43637.

Carpolithus spp. p. 154

7, 8. Immature fruits? ×15. V.43635–36.

9. Endocarp with gaping aperture at one end. ×6·5. V.43101.
10. Same, seen from opposite side. Endocarp wall broken and shows remains of septum at (*s*) probably delimiting an abortive locule. ×6·5.

Unidentified Tendril p. 156

11. Tendril with subterminal hook-like process. ×6·5. V.43629.
12. Same, opposite side. ×6·5.

Spiny petioles? p. 156

13. Edge of stem with curved spine. ×6·5. V.43613.
14. Another with raised rounded marginal area bearing curved flattened spines. ×6·5. V.43612.
15. Specimen with two slender curved spines with broken tips. ×6·5. V.43614.
16. Another with remains of two spines, much corroded and battered. ×6·5. V.43615.
17. Specimen with one spine (tip broken). ×6·5. V.43616.
18. Another with two spines. ×6·5. V.43618.
19. Small specimen with close-set spines. ×6·5. Decayed.
20. Larger specimen. ×6·5. V.43617.
21. Much flattened fragment with sharp-edged curved spines. ×2·8. V.43619.

Unknown organism (Galls?) p. 158

22. Unknown organ of pod-like appearance with nervation on the broad surface. Imperfect at one end, prolonged into stalk at the other. ×6·5. V.43620.
23. Another, marginal view, broken at one end, abraded at the other. ×6·5. V.43622.

Fig.

24. Another, imperfect, to show double row of marginal "plugs". ×6·5. V.43624.
25. Specimen split longitudinally parallel with broad surfaces to show cavities which are closed by "plugs" and manner in which they are arranged. ×6·5. V.43623.
26. Another similar specimen to show marginal "plugs" and apertures from which some "plugs" have fallen. ×6·5. V.43621.
27. Same, side. ×6·5.

Carpolithus sp. p. 155

28. Winged fruit represented by an obscure locule cast surrounded by a wing or wings with radial nervation and entire margin. Reminiscent of Juglandaceae—*Pterocarya* but evidence inconclusive. ×2·2. V.43571.

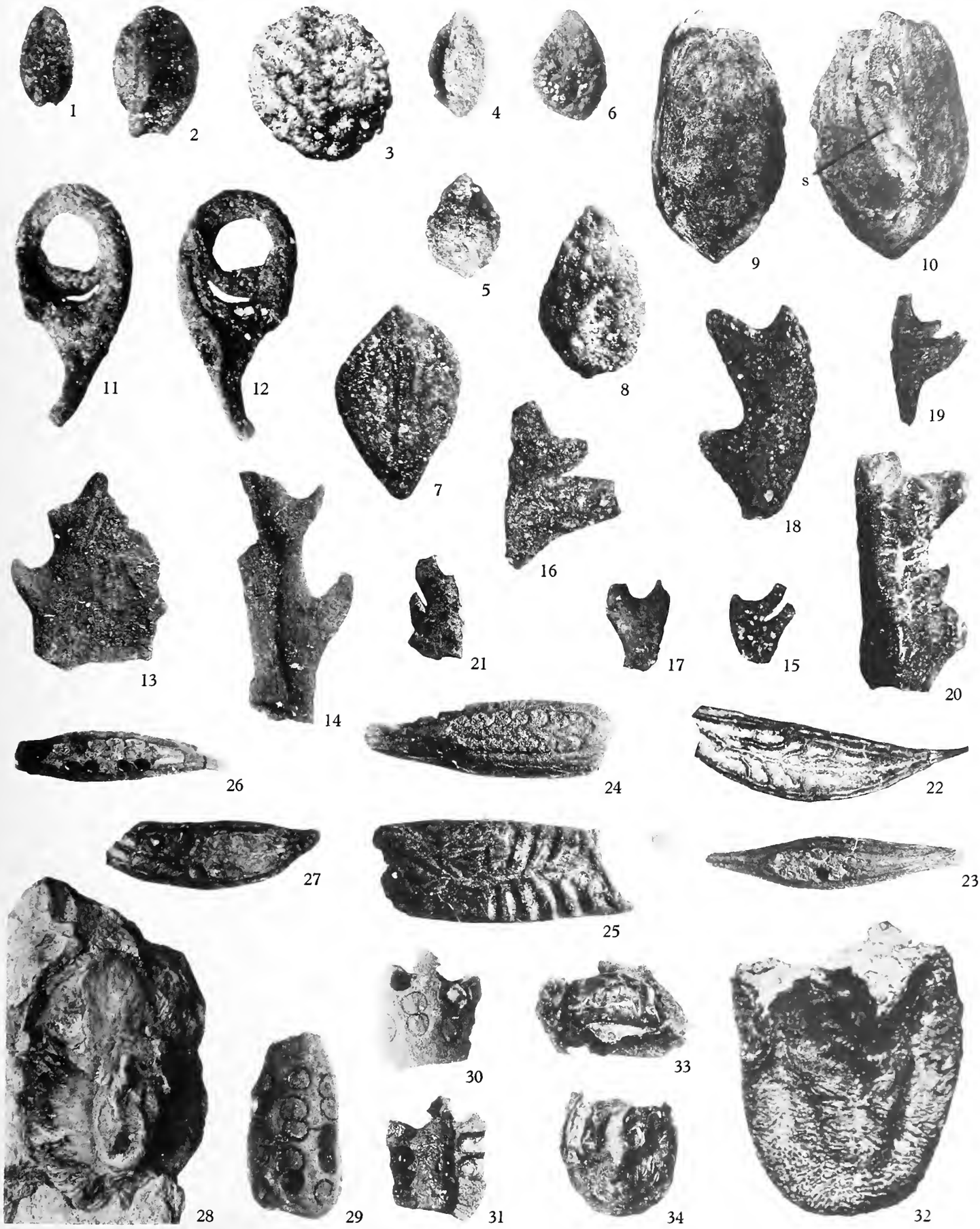
Galls? p. 159

29. Subcylindrical body with cup-like cavities occupied by solid plugs of tissue arranged in pairs in longitudinal rows. In several places plugs have fallen out showing cavities they occupied. ×6·5. V.43627.
30. Part of another specimen which has broken longitudinally. ×6·5. V.43628.
31. Fractured surface of this specimen showing a cylindrical central cavity and marginal cup-like cavities from which plugs have gone. Note shining surface of cavities. ×6·5.

Tuber? p. 156

32. Hollow subglobular chitinous body, now burst at one end with scaly surface in places. ×15. V.43638.
33. Another, burst. It shows a thin inner skin. ×6·5. V.43639.
34. Another, side, burst at one end. ×6·5. Decayed.

Figs. 3–5, 7, 8, 11, 12, 22–28, 32–34 Bournemouth Freshwater Beds: Figs. 3, 5 Branksome Dene; Figs. 4, 11, 12, 22–27, 32–34 Sandbanks; Figs. 7, 8, 28 between Alum and Middle Chines, Bournemouth. Fig. 6 carbonaceous lenticle, base of Boscombe Sands; and Figs. 9, 10, 15–20 Lignite above Boscombe Sands, Southbourne. Figs. 13,14 Bournemouth Marine Beds, Leafy lenticle, cliff base, Southbourne. Figs. 1, 2, 21, 29–31 Beds 2 and 3 of Geological Survey, Cliff End, Mudeford.



CARPOLITHUS, TENDRIL, PETIOLES (?), GALLS (?), TUBER (?)